Santos

Darwin Pipeline Duplication (DPD) Project NT EPA Referral

PROJECT / FACILITY	DPD Project
REVIEW INTERVAL (MONTHS)	No Review Required
SAFETY CRITICAL DOCUMENT	NO

Rev	**Owner**	**Reviewer/s** *Managerial / Technical / Site*	**Approver**
	Project Delivery Manager	**Principal Environmental Adviser**	**Project Director**
0			

Any hard copy of this document, other than those identified above, are uncontrolled. Please refer to the Santos Offshore Business Document Management System for the latest revision.

Rev	Rev Date	Author / Editor	Amendment
A	16/11/2021	CDM Smith	Issued for Review
B	30/11/2021	CDM Smith	Issued for Review
0	08/12/2021	CDM Smith	Issued for Use

Executive Summary

Santos' Darwin Pipeline Duplication (DPD) Project will enable natural gas from offshore reservoirs to be exported to the existing Santos Darwin Liquefied Natural Gas Facility (DLNG) with minimal environmental and social impact. Similar gas export pipeline developments have been successfully managed in the Northern Territory, and there is a significant body of knowledge available that provides confidence in the environmental assessment and management effectiveness.

Importantly, executing the DPD Project in a timely manner preserves the existing Santos Bayu-Undan to Darwin pipeline for re-purposing opportunities into the future including carrying carbon dioxide for offshore carbon capture and storage (CCS). This opportunity will help Santos meet its emission reduction targets and achieve net-zero Scope 1 and 2 absolute emissions by 2040.

Santos' Darwin Pipeline Duplication (DPD) Project includes a ~23 km segment in Commonwealth waters (referred to as the 'Additional Barossa GEP Segment) and ~100 km segment in NT waters and lands (referred to as the 'Nearshore Barossa GEP'). The Project pipeline will be located parallel to the existing Bayu-Undan to Darwin pipeline, to minimise potential environmental and social impacts.

This referral supporting information document addresses the activities required to construct and operate the new pipeline segment in NT waters and lands only (i.e. the Nearshore Barossa GEP; herein referred to as the 'Project'). This document provides supporting information to the Referral Form for the DPD Project in NT waters and lands submitted under Section 48 of the NT Environment Protection Act 2019 to the NT Environment Protection Authority (NT EPA). The conclusion that the Project activities will have minimal impact and are readily manageable using well established pipeline construction and operational practices is based on the following:

+ The Project is smaller in scale to previous gas export pipeline and marine infrastructure developments within Darwin Harbour;
+ The Project pipeline is immediately adjacent to the existing Santos Bayu-Undan to Darwin pipeline and the shore crossing is located within the existing DLNG facility disturbance envelope;
+ There are three 'sea themed' environmental factors requiring detailed assessment and focused management. All other environmental factors are considered insignificant following a screening process, as presented within the document;
+ There is a substantial body of location-specific scientific and management knowledge, with the key environmental and social values in the area being well understood. Santos has conducted recent environmental surveys to confirm the absence of sensitive or restricted environmental receptors along the Project pipeline;
+ No further supplementary information is required to improve the certainty of the environmental impact assessment, with a small number of technical studies proposed to inform and refine environmental management plans and monitoring program which will become publicly available;
+ There is confidence in the effectiveness of the proposed management measures based on previous experiences and as validated by extensive environmental monitoring results; and
+ Sufficient stakeholder engagement has occurred with a commitment for ongoing stakeholder engagement and provision of public.

Santos proposes to complete a small number of technical studies to inform the proposed management plans. These include:

+ Sediment dispersion modelling: to confirm the likely spatial and temporal extent of suspended sediments and sedimentation from construction activities to inform the marine environmental monitoring program;
+ Spill modelling (from vessels): including modelling the fate and effect of unplanned and accidental marine-related hydrocarbon spills during construction activities to inform spill preparedness and response arrangements;
+ Underwater noise modelling: to quantify potential noise emissions and exposures from construction activities to inform marine fauna management measures; and
+ Acid sulphate soil (ASS) assessment: to assess the presence of ASS prior to disturbance, a survey will be conducted to test soils within the shore crossing location. Where ASS is detected, this data will be used to inform an Acid Sulphate Soils Management Plan (ASSMP).

Santos commits to implementing construction and operations environmental management plans to ensure impacts and risks are acceptable and as low as reasonably practicable. A marine environmental monitoring program will also be implemented for the project construction phase.

Santos proposes to commence pre-lay works in Quarter 1 2023. This will enable the DPD Project to be completed and connected to the original stage of the Santos Barossa Gas Export Pipeline (GEP) in readiness for introducing gas in the first half of 2025.

Acronyms and Abbreviations

Acronym	Definition
AAPA	Aboriginal Areas Protection Authority
ACCUs	Australian Carbon Credit Units
ADCP	Acoustic Doppler Current Profiler
AFANT	Amateur Fishermen’s Association of the Northern Territory
AFFF	Aqueous Film-Forming Foam Concentrates
AFZ	Australian Fishing Zone
AHD	Australian Height Datum
AIMS	Australian Institute of Marine Science
ALAN	Artificial Light At Night
ALARP	As Low As Reasonably Practicable
ANPM	Autoridade Nacional do Petróleo e Minerais
AS	Australian Standard
ASS	Acid Sulphate Soil
ASSMP	Acid Sulphate Soils Management Plan
ATSB	Australian Transport Safety Bureau
AUV	Autonomous Underwater Vehicles
AWR	Air Weapons Range
BHD	Backhoe dredger
BIAs	Biologically Important Areas
BOM	Bureau of Meteorology
BTEXN	Benzene, Toluene, Ethylbenzene, Naphthalene
CCS	Carbon Capture and Storage
CEMP	Construction Environment Management Plan
CPT	PiezoCone penetration test
CR	Critically Endangered
CSD	Cutter Suction Dredgers
CTD	Conductivity-temperature-depth
oC	Degrees Celsius
DAWE	Department of Agriculture, Water and Environment
dB	Decibel

DENR	Department of Environment and Natural Resources
DEPWS	Department of Environment, Parks and Water Security
DIPL	Department of Infrastructure, Planning and Logistics
DITT	Department of Industry, Tourism and Trade
DLNG Facility	Darwin Liquefied Natural Gas Facility
DoD	Department of Defence
DoH	Department of Health
DoEE	Department of Environment
DPD	Darwin Pipeline Duplication
DP	Dynamically positioned
EDP	Exceptional Development Permit
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EN	Endangered
EP	Environment Plan
EP Act	*Environment Protection Act 2019* (Northern Territory)
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)
EPL	Environment Protection Licence
ERF	Emissions Reduction Fund
FCGT	Flood, clean, gauge, testing
FEED	Front End Engineering Design
FFPV	Flexible fall pipe vessel
FPSO	Floating Production Storage and Offloading
GA	Geoscience Australia
GEL	Generally Expected Levels
GEP	Gas Export Pipeline
GHG	Greenhouse Gas
Ha	Hectare
HFO	Heavy Fuel Oil
Hz	Hertz
IAP	International Association for Public Participation
IFO	Intermediate Fuel Oil

IMMRP	Integrated Marine Monitoring and Research Program
IMR	Inspection, maintenance and repair
IMOS	Integrated Marine Observing System
ILT	In-line tee
km	Kilometre
km/hr	kilometre per hour
KP	Kilometre Point
LAT	Lowest Astronomical Tide
LBL	Long base line
LDC	Land Development Corporation
LNG	Liquefied Natural Gas
LoR	Limit of Reporting
m	Metre
MDO	Marine Diesel Oil
mm	Millimetre
MNES	Matters of National Environmental Significance
MBES	Multi-beam echosounder
MASW	Multi-channel analysis of surface waves
MEG	Monoethylene Glycol
MTPA	Million tonnes per annum
NEMP	Nearshore Environmental Monitoring Program
NGER Act	*National Greenhouse and Energy Reporting Act 2007*
NL	Not Listed
NMR	North Marine Region
NOI	Notice of Intent
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority
NORMs	Naturally occurring radioactive materials
NOPTA	National Offshore Petroleum Titles Administrator
NT	Northern Territory
NT EPA	NT Environment Protection Authority
NTG	Northern Territory Government
NT PFES	NT Police, Fire and Emergency Services

NTPS	Northern Territory Planning Scheme
NTU	Nephelometric Turbidity Units
NVIS	National Vegetation Information System
OCP	Organochlorine pesticides
OEMP	Operations Environmental Management Plan
OPGGS Act	*Offshore Petroleum and Greenhouse Gas Storage Act 2006*
OPP	Offshore Project Proposal
PAH	Polynuclear Aromatic Hydrocarbons
PASS	Potential Acid Sulphate Soil
PCB	Polychlorinated Biphenyls
PCPT	Piezocone penetration test
PER	Public Environmental Review
PLET	Pipeline End Termination
PLRs	Pig launcher/receivers
PCBs	Polychlorinated biphenyls
PMST	Protected Matters Search Tool
PTS	Permanent Threshold Shift
PWC	Power and Water Corporation
QRA	Quantitative Risk Assessment
RL	Relative Level
RPA	Reef Protection Area
RO	Reverse Osmosis
ROVs	Remotely Operated Vehicles
RWA	Restricted Work Area
SBP	Sub-bottom profiler
SDS	Safety Data Sheet
SDV	Side dumped vessel
SEP	Stakeholder Engagement Plan
SER	Supplementary Environmental Report
SOCS	Site of Conservation Significance
SOPEP	Ship Oil Pollution Emergency Plan
SSS	Side scan sonar

TBT	Tributyl Tin
TKN	Total Kjeldahl Nitrogen
TMP	Traffic Management Plan
ToR	Terms of Reference
TP	Total Phosphorus
TPWC Act	*Territory Parks and Wildlife Conservation Act 1976* (Northern Territory)
TRH	Total Recoverable Hydrocarbons
TSHD	Trailing suction hopper dredger
TSS	Total suspended solids
TSDMMP	Trenching and Spoil Disposal Management and Monitoring Plan
TTS	Temporary Threshold Shift
USBL	Ultra-short base line
UXO	Unexploded Ordnance
VU	Vulnerable
WDL	Waste Discharge Licence
WQO	Water Quality Objectives
WQMP	Water quality monitoring program
WoNS	Weeds of National Significance

Contents

Figures

Tables

Appendices

1 Introduction

1.1 Document purpose

This document provides supporting information to the Referral Form for the Santos Darwin Pipeline Duplication (DPD) Project, submitted under Section 48 of the Northern Territory (NT) Environment Protection Act 2019 to the Environment Protection Authority (NT EPA). This supporting information document includes a completed NT EPA Pre-Referral Screening Tool and has been prepared in accordance with NT EPA Environmental Impact Assessment Guidance for Proponents – Referring a Proposal to the NT EPA (NT EPA, 2021a).

1.2 Project context

As a proudly Australian energy producer, Santos has improved the lives of people throughout Australia and Asia for more than 65 years by providing safe, reliable and cleaner energy. With assets spanning Australia, Papua New Guinea and Timor-Leste, our focus is continuing and expanding this mission through cleaner, low-cost fuels. Critical within this vision is management of greenhouse gas emissions, as detailed in our 2021 Climate Change Report.

Santos' role in low-carbon future is built around natural gas, which produces half the greenhouse gas emissions of coal when used to generate electricity. It is the perfect partner for renewable energy sources and can be made even cleaner with carbon capture and storage (CCS).

At Santos we are evolving our business to drive deeper emission abatement through our leading position in the critical technology of CCS. This will drastically lower our operating emissions and provide permanent, low-cost CO_2 abatement for other industries. Eventually, it will unlock production of zero-emission hydrogen produced from natural gas, by sequestering the CO_2 emissions released during the process.

Our existing LNG customer base in Asia will be the hydrogen customers of the future, and as they transition to new clean fuels, Santos will transition with them. This transition is supplemented by our continued investment in operational efficiency, renewables integration and the high quality carbon offset projects to reduce our emissions on the journey to net-zero. Santos' commitment to developing cleaner, low-cost fuels across the energy horizon positions the company to not just be resilient, but to thrive in a low-carbon future.

CCS is recognised as a safe, well established solution for permanent, large-scale emissions reduction and clean energy production, being the keys to economy-wide decarbonisation. In November 2021, Santos sanctioned development of the globally significant Moomba CCS Project: the world's second largest CCS project. Phase one of the Moomba CCS project aims to inject up to 1.7 million tonnes of CO_2 emissions per annum from the Moomba Gas Plant. This significant US$165 million investment decision is evidence of Santos commitment to CCS technology and a lower carbon future.

In September 2021, Santos signed a Memorandum of Understanding (MOU) with the Timor-Leste regulator Autoridade Nacional do Petróleo e Minerais (ANPM) to progress CCS at Bayu-Undan in the Timor Sea (refer to **Section 1.8**). CCS at Bayu-Undan has potential capacity to safely and permanently store approximately 10 million tonnes per annum of CO_2. The foundation project being studied involves the transport of CO_2 from the existing Santos-operated Darwin LNG (DLNG) Facility via the existing Bayu-Undan to Darwin Pipeline for injection into the depleted Bayu-Undan reservoir. Re-purposing of existing infrastructure provides the most economically viable development option for the CCS opportunity.

This development concept requires a significant capital investment from the approved Santos Barossa Development in order to be “CCS Ready”. The major investment is the construction of an additional segment of pipeline to extend the Barossa Development gas export pipeline to the DLNG Facility, with approximately 100 km of the additional segment in Northern Territory waters. The additional segment of pipeline would be laid in parallel to the existing Bayu-Undan to Darwin Pipeline. The additional segment of pipeline herein is referred to as the Darwin Pipeline Duplication (DPD) Project (refer to **Section 1.6**).

Santos has submitted this Referral to advance the environmental approvals for the DPD Project. Development context relevant to the DPD Project is provided below.

1.3 Darwin LNG Facility

The Darwin LNG (DLNG) Facility has been operating in Darwin since 2006 . Santos is the designated plant and pipeline operator for these assets.

The DLNG Facility is located at Wickham Point on the Middle Arm Peninsula in Darwin Harbour. The DLNG Facility is located approximately 6 km south-to-south-east of Darwin.

The DLNG Facility currently receives dry natural gas from the Santos-operated Bayu-Undan Field, located in Timor Leste, via the 502-km long Bayu-Undan to Darwin Pipeline, for the purpose of producing LNG for export overseas.

The DLNG Facility has a maximum instantaneous capacity, or nameplate capacity, equivalent to 3.7 million tonnes per annum (MTPA). The 3.7-MTPA DLNG Facility is the first train, with regulatory approvals in place for a 10-MTPA LNG Facility.

Bayu-Undan Field feed gas contains approximately 6 mol% CO_2. The removal of CO_2 from the feed gas is important to eliminate any freezing problems within the downstream liquefaction system. Carbon dioxide is removed from the feed gas using a regenerated amine system (an absorber) and acid gas incinerator resulting in atmospheric emissions, including greenhouse gases, from the DLNG Facility.

DLNG Facility greenhouse gas emissions are reported annually in accordance with the requirements of the Commonwealth *National Greenhouse and Energy Reporting Act 2007* (NGER Act). Reported emissions for the 2020/2021 reporting period were 1.6 million tonnes (Mt) of CO_2-e. Greenhouse gas emissions are also managed under the *National Greenhouse and Energy Reporting (Safeguard Mechanism) Rule 2015*.

The end of field life for Bayu-Undan is expected to occur in 2022-2023 based on current reservoir knowledge and production forecasts. In March 2021, the Barossa Field was selected by joint venture partners to provide backfill feed gas and to extend the life of DLNG for another ~20 years (refer to **Section 1.4** and **1.5**).

1.4 Darwin LNG Facility: approved life extension

The approved DLNG Life Extension requires partial modification and refurbishment of the existing DLNG Facility to support the new Barossa Field feed gas and extend operation of the facility beyond its original design life.

The facility is planned to operate at a nominal throughput of 3.7 MTPA LNG production, consistent with the current nameplate capacity.

The DLNG Life Extension is a ‘brownfields’ work program and comprises two key phases; a transition period, followed by future (extended) operations to approximately 2050. In the transition period, production will cease from the existing Bayu-Undan gas supply. The majority of the plant will be hydrocarbon free and preserved during the transition period, with the exception of the LNG tank which will be kept cool for the duration of the transition. The transition period is an enabling window for key work scopes to be completed to ensure the DLNG Facility is ready for continued operations.

The new feed gas and modifications to the DLNG Facility will result in changes to fuel gas use and efficiencies. Greenhouse gas emissions forecast estimates for the DLNG future operations indicate that future operations will result in a slight increase in emissions (approximately 5%). The DLNG Facility will continue to be managed under the Safeguard Mechanism Rules.

The DLNG Life Extension was approved by the NT EPA under the Northern Territory (NT) *Environmental Assessment Act 1982* in May 2020. An amendment to the existing Environment Protection Licence (EPL) as issued under NT *Waste Management and Pollution Control Act 2016* is required prior to commencement of the project.

1.5 Backfill to DLNG: approved base case

The ~US$5 billion Barossa Development was sanctioned for development by joint venture partners in March 2021 as the preferred backfill feed gas for DLNG. The development is well advanced with all major construction contracts executed and development drilling planned for early 2022. An overview of the Barossa Development is provided below and illustrated in **Appendix A**.

The Barossa Field is a gas-condensate field located offshore in the Timor Sea, approximately 300 km north-northwest of Darwin.

The base case concept comprises a subsea development with two phases of development drilling and late life compression, tied into an floating production storage and offloading (FPSO) facility with a 730 MMscf/d export gas design capacity. The development will require installation of a new 260-km, 26 inch diameter gas export pipeline from the FPSO to a tie-in point on the existing Bayu-Undan to Darwin Pipeline, once existing gas supply from the Bayu-Undan Field ceases. The condensate will be stored in the FPSO prior to offload to a tandem-moored tanker.

The FPSO will separate gas, condensate and produced water, as well as remove mercury and bulk CO_2 prior to exporting lean gas to the DLNG Facility. It is premised that CO_2 will be removed offshore prior to delivery into the gas export pipeline, to a level that is compatible with the existing Bayu-Undan feed gas and DLNG gas specification. The native CO_2 content of the reservoir gas varies across the field, with an assumed average of 18 mol%. Native CO_2 in the reservoir raw gas is removed on the FPSO via CO_2 removal membranes to achieve an export gas CO_2 content of ~6 mol%. Base case is that the removed native CO_2 will ultimately be routed to atmosphere via the FPSO.

The Barossa wells and facilities are designed to deliver an annual average LNG production of approximately 3.5 MTPA. The development objective is to achieve first gas in the first half of 2025, with expected continued production for the next 15-20 years. There are late life opportunities to extend the field life, as well as potential nearby resource development options (e.g., the Caldita Field).

In recognition of future potential CCS opportunities, Santos has pre-invested in the facilities design to allow future export of all Barossa native CO_2 to DLNG.

Based entirely within Commonwealth waters, Barossa environmental approvals are being managed by NOPSEMA. NOPSEMA accepted the Barossa Area Development Offshore Project Proposal (Barossa OPP) in March 2018 and the Barossa Gas Export Pipeline Installation Environment Plan (GEP EP) in March 2020. As the current development base case for the supply of backfill gas to DLNG, Santos will continue to progress all regulatory planning approvals with NOPSEMA.

Similar to the DLNG Facility, the Barossa FPSO will report emissions annually in accordance with the requirements of the NGER Act and emissions will be managed under the Safeguard Mechanism Rule.

1.6 Backfill to DLNG: alternative gas export pipeline (the DPD Project)

In recognition of future potential CCS opportunities, Santos has pre-invested in the facilities design to allow future export of all Barossa native CO_2 to DLNG.

One such opportunity being assessed is potential CCS at Bayu-Undan in the Timor Sea using carbon dioxide exported from the DLNG Facility. In order to preserve the Bayu-Undan to Darwin Pipeline to carry carbon dioxide for this opportunity, Santos is considering further pre-investment by extending the Barossa Gas Export Pipeline (GEP) all the way to DLNG. If sanctioned, this would negate the need for a tie-in point on the existing Bayu-Undan to Darwin Pipeline and represent a change to the Barossa Development base case (refer to **Section 1.5**).

As referenced above, the additional segment of pipeline required to extend the Barossa GEP to DLNG is referred to as the Darwin Pipeline Duplication (DPD) Project in this Referral.

The DPD Project includes a ~23 km segment in Commonwealth waters (referred to as the 'Additional Barossa GEP Segment) and ~100-km segment in NT waters and lands (referred to as the 'Nearshore Barossa GEP') (**Figure 1-1**). The Additional Barossa GEP Segment will be connected to the original Barossa Gas Export Pipeline (GEP), approved for construction from quarter 4 2022.

The Additional Barossa GEP Segment is being managed in accordance with relevant Commonwealth legislation. This Referral supporting information document addresses the activities required to construct and operate the new pipeline segment in NT waters and lands only (e.g. the Nearshore Barossa GEP; or the 'Project').

The Nearshore Barossa GEP will be laid parallel to, and for most parts approximately 100 metres from, the existing Bayu-Undan to Darwin Pipeline. The effective 'duplication' of the existing Bayu-Undan to Darwin Pipeline is considered the optimal route to minimise potential environmental and social impacts.

Site investigation works (e.g. geophysical, geotechnical and environmental surveys) required to inform detailed engineering are excluded from this Referral as the potential environmental impacts and risks are considered insignificant in nature and scale.

Further, while the Nearshore Barossa GEP has been designed to safely receive third party gas via an in-line tee (valve), the third-party connecting pipeline does not form part of this Referral (refer to **Section 1.7**).

Connection of the Nearshore Barossa GEP to the DLNG Facility and processing of the pipeline gas will be managed in accordance with existing and amended DLNG NT approvals (refer to **Appendix B**); hence, these activities are excluded from this Referral.

Santos

Should the DPD Project be sanctioned in quarter 1 2022 then Santos is proposing to commence pre-lay works in quarter 1 2023. This will enable the DPD Project to be completed and connected to the approved original stage of the Santos Barossa GEP in readiness for introducing gas in the first half of 2025.

Should the DPD Project not be sanctioned in a timely manner to meet Barossa first gas milestones, then Santos will continue with the Barossa Development Base Case (i.e. Barossa GEP tie-in to Bayu-Undan to Darwin Pipeline) (refer to **Section 1.5**).

1.7 Backfill to DLNG: gas export pipeline including third party gas alternative

Extending the Barossa GEP to DLNG enables the design and installation of an in-line tee (valve) within the Nearshore Barossa GEP. This valve enables the future potential tie-in of third party gas for processing at DLNG. While the pipeline has been designed to safely receive third party gas, a third-party connecting pipeline does not form part of this Referral.

1.8 Future DLNG Development: Bayu-Undan CCS Opportunity

The Bayu-Undan CCS Opportunity has the potential to be the largest CCS project in the world enabling a potential step reduction in Santos' greenhouse gas emissions and enabling potential clean energy developments in the NT. An animation of the opportunity is available at Santos' CCS Opportunities.

Santos is well advanced in concept engineering for a foundation project, which has identified the conceptual DLNG Facility modifications and confirmed only minor pipeline equipment modifications.

The DLNG Facility modifications are required to receive Barossa gas at a nominal 730 MMscf/d and remove and compress the CO_2 for export to Bayu-Undan. Conceptual DLNG Facility modifications would include modification or installation of plant inlet equipment, CO_2 removal equipment, acid gas removal and disposal units, and dehydration and compression equipment; with additional power generation. The engineering premise is that all modifications would be within the existing DLNG Facility disturbance envelope.

Fundamentally, the concept is that the Bayu-Undan CCS Opportunity would result in a significant reduction in total CO_2 emissions from the Barossa Development and DLNG Facility. There is also potential for future expansion of the opportunity by receiving and permanently storing CO_2 on behalf of other industrial emitters at a Darwin CCS hub.

Santos is aiming to enter front-end engineering design (FEED) phase in the first half of 2022, at which point long-lead regulatory approvals would be progressed across multiple jurisdictions including with the NT Environment Protection Authority (EPA).

1.9 Forward plan

Santos has commenced execute phase engineering, facility fabrication and construction for parts of the DLNG Life Extension and Barossa Development. The Barossa Development target is for first gas in the first half of 2025, subject to the receipt of all regulatory approvals.

In parallel, Santos is progressing FEED and long-lead regulatory approvals for the DPD Project, and is progressing towards a final investment decision target of the first half of 2022. Given the DPD Project alters the current Barossa Development base case and involves a significant capital commitment, preservation of the Barossa first gas milestone and business confidence in the Bayu-Undan CCS Opportunity and associated regulatory approvals will be key final investment decision considerations.

Given the long-lead construction time frames associated with the DPD Project, a final investment decision is required in advance of the Bayu-Undan CCS Opportunity final investment decision. Santos is progressing towards a Bayu-Undan CCS Opportunity final investment decision target of early 2023 so to commence CCS during the early years of Barossa production.

In the event the Bayu-Undan CCS Opportunity is deferred or not advanced, then Santos would assess Bayu-Undan to Darwin Pipeline preservation, re-purposing and decommissioning options in accordance with legislative obligations.

1.10 Referral approach

The approach for this referral has been to draw upon existing publicly available data, learnings and experience from other comparable developments and activities to inform the Project impact assessment, and to develop a suitable management framework. This body of existing knowledge, augmented by site-specific field surveys, provides assessment and management confidence.

This supporting information document focuses on the environmental factors identified as being the most at risk and requiring detailed assessment and focused management. These factors are marine-orientated and are Marine Environmental Quality, Marine Ecosystems and Coastal Processes. The assessment of other 'not significant' environmental factors is included as **Appendix G**.

In summary the referral demonstrates that:

+ The Project is smaller in scale to previous gas export pipeline and marine infrastructure developments within Darwin Harbour;
+ The Project pipeline is immediately adjacent to the existing Santos Bayu-Undan to Darwin pipeline and the shore crossing is located within the existing DLNG facility disturbance envelope;
+ There are three 'sea themed' environmental factors requiring detailed assessment and focused management. All other environmental factors are considered insignificant following a screening process, as presented within the document;
+ There is a substantial body of location-specific scientific and management knowledge, with the key environmental and social values in the area being well understood. Santos has conducted recent environmental surveys to confirm the absence of sensitive or restricted environmental receptors along the Project pipeline;
+ No further supplementary information is required to improve the certainty of the environmental impact assessment, with a small number of technical studies proposed to inform and refine environmental management plans and monitoring program which will become publicly available;
+ There is confidence in the effectiveness of the proposed management measures based on previous experiences and as validated by extensive environmental monitoring results;
+ Sufficient stakeholder engagement has occurred with a commitment for ongoing stakeholder engagement and provision of public.

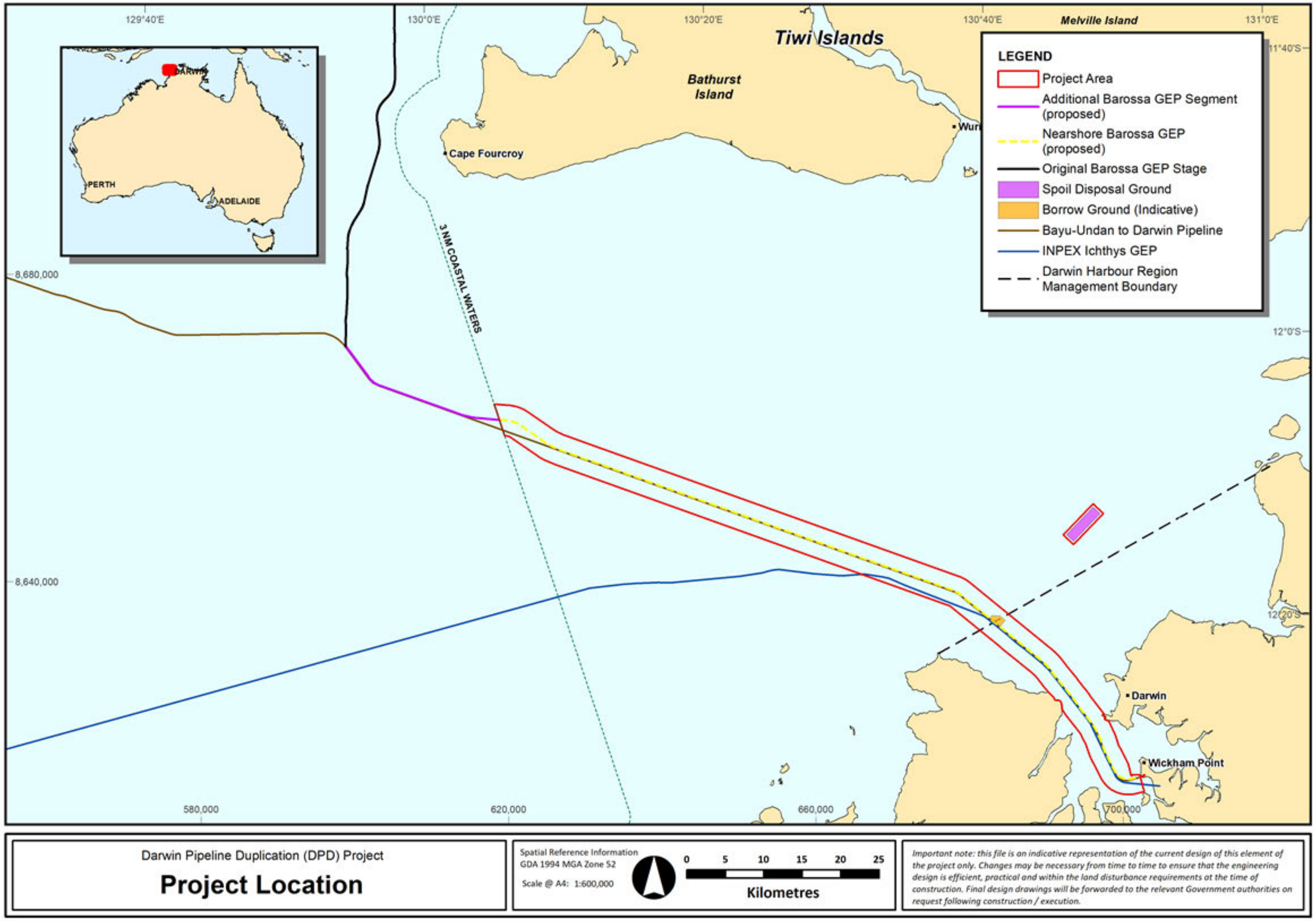


Figure 1-1 Project location

1.11 Proponent details

The proponent details are outlined in **Table 1-1**.

Table 1-1 Proponent details

Business name	Santos NA Barossa Pty Ltd	
Contact Person	Nick Phillips	
Postal Address	53 Ord Street, West Perth, WA 6005	
Contact	Barossa.regulatory@santos.com	

1.12 Environmental consultant details

CDM Smith Australia Pty Ltd (CDM Smith) have prepared this referral on behalf of Santos. The key contact for CDM Smith is outlined below in **Table 1-2**.

Table 1-2 Consultant contact details

Business name	CDM Smith Australia Pty Ltd	listen. think. deliver.
Contact Person	Paul Davey	
Postal Address	Level 1, 48-50 Smith Street, Darwin NT 0800	
Contact	DaveyP@cdmsmith.com	

2 Environmental Approval Process and Relevant Legislation

The two key primary environmental approvals relating to the Project in the Northern Territory jurisdiction include referral under section 48 of the *Environment Protection Act 2019* (NT), and consideration of Commonwealth protected Matters of National Environmental Significance (MNES) under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

A preliminary list of required Northern Territory and Commonwealth approvals, licences and permits that may be required for the Project to proceed are set out in **Appendix B**. **Appendix B** summarises the existing approvals and their scope as relevant to the Project.

2.1 Northern Territory Environment Protection Act

The Environment Protection Act (EP Act) and associated regulations replaced the *Environmental Assessment Act 1999* on 28 June 2020. The EP Act aims to promote ecological sustainable development, manage significant disturbances through an environmental approval process, provide for broader community involvement and recognise the importance of participation of Aboriginal people and communities in environmental decisions. Under the Act, the NT EPA regulates the environment impact assessment process to identify potential environmental impacts of development proposals. This initial step is undertaken through a referral in which the NT EPA then determines if further assessment is required.

There are four assessment methods provided for within the NT approvals process:

1. Assessment on referral information (Tier 1);
2. Assessment on a Supplementary Environmental Report (SER) (Tier 2);
3. Assessment by Environmental Impact Statement (EIS) (Tier 3); and
4. Assessment by inquiry.

This supporting information document has been prepared to assist the NT EPA in determining an appropriate assessment method.

2.2 Commonwealth EPBC Act and Matters of National Environmental Significance

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) provides for the protection of the environment and conservation of biodiversity in Australia (including Australian waters). Matters of National Environmental Significance (MNES) are protected under Part 3 of the Act and projects require approval under the Act if they are likely to result in a significant impact on MNES. A self-assessment against the EPBC Significant Impact Guidelines 1.1, was undertaken to determine whether referral under the EPBC Act is required for the Project. While Santos has concluded that significant impacts to MNES are unlikely, an EPBC Act referral for the Project (in NT waters) will be made. Refer to **Section 10.4** for the EPBC Significance test self-assessment.

The National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) consider MNES listed under the EPBC Act in their environmental assessments of offshore petroleum and greenhouse gas storage activities within Commonwealth jurisdiction, under the *Offshore Petroleum and Greenhouse Gas Storage Act 2006* (OPGGS Act). Therefore, assessment and approval is not required from the Commonwealth Minister for the Environment in these circumstances, as relevant to petroleum activities within Commonwealth waters. The Commonwealth waters section of the DPD Project (~23 km, referred to as Additional Barossa GEP Segment) is being addressed through an Environment Plan revision, as a new stage of the Barossa GEP, under the OPGGS (Environment) Regulations 2009.

3 Project Description

3.1 Overview

Santos is proposing the development of the Project to enable gas from offshore reservoirs to be transported to the existing DLNG facility. The Project pipeline will be located parallel to, and hence is effectively a 'duplication' of, a portion of the existing Bayu-Undan to Darwin pipeline.

This section provides an overview and description of the key characteristics of the Project, as summarised in **Table 3-1**.

Table 3-1 Key characteristics of the Project

Component	Size / capacity
Key Infrastructure	
Pipeline	The pipeline will be ~100 km in NT waters. The pipeline diameter is 26 inches up to an in-line tee (approximately 60 km offshore), after which the pipeline increases to 34 inches. Seabed disturbance will be within a 50 m disturbance corridor along the Project pipeline, with additional disturbance closer to shore due to vessel anchoring. Pipeline will extend to the DLNG facility but not connect into the process plant as part of this referral.
Borrow ground	Sediment (borrow) may be required to provide backfill for trenching. This borrow ground will be located in the sand wave region at the mouth of the harbour. The indicative volume of the borrow ground has been estimated to be greater than 1,500,000 m^3. It is anticipated that if required, up to a maximum of ~500,000 m^3 of rock placement material will be required for trench backfill pending over-trench and contingency trenching. The anticipated volume is expected to be ~200,000 m^3.
Spoil disposal ground	Spoil that is collected during the trenching activities will be disposed in a location north-east of Darwin Harbour. The area of the spoil disposal ground is 6.25 km^2. This includes a 100 m buffer around the perimeter. The maximum volume of spoil is anticipated to be ~750,000 m^3 pending over-trench and contingency trenching. The anticipated volume is expected to be ~250,000 m^3.
Shore crossing	The pipeline will be trenched and buried at the shore crossing. The length of pipeline trenching onshore will be approximately 300 m. Extension of the pipeline to connect to DLNG (outside the scope of this referral) will be approximately 800 m.

Onshore facilities	All onshore temporary facilities including shore pull, laydown and ancillary facilities will be on NT land within the existing DLNG disturbance envelope. The onshore Project Area is approximately 4 ha and is contained wholly within the DLNG disturbance envelope.
Construction Elements	
Duration	Construction to commence Q1 2023 and is estimated to take approximately 15 months to complete.
Operations Elements	
Pipeline product	Natural gas
Operation life	First gas in first half of 2025 with operation ~25 years
Decommissioning Elements	
Proposed decommissioning	At end of Project life (>2050)

3.2 Project pipeline

The Project pipeline runs parallel to the existing Bayu-Undan to Darwin pipeline, and comes onshore at the DLNG facility (**Figure 1-1**). Alternatives for pipeline routing were evaluated, giving consideration to the following criteria:

+ Proximity to the pre-disturbed Bayu-Undan to Darwin pipeline and shore crossing;
+ Avoiding areas of environmental (including heritage) values and sensitivities;
+ Avoiding any seabed hazards;
+ Minimising long term integrity risks and/ or intervention requirements;
+ Minimising the number of pipeline crossings, e.g., existing pipelines or communication cables;
+ Minimising encroachment on the Darwin Harbour shipping channel; and
+ Minimising risk to other assets during construction.

Santos continues to evaluate the preferred Project pipeline between a northern and central route as described in **Section 5.2**. Both route options are within the Project Area (as described in **Section 3.3**), however for the purpose of this referral, the northern route has been shown on figures as this is the preferred option.

3.3 Project Area

For the purpose of the assessment, the Project Area has been defined to include the extent of all planned activities in the NT, as described in **Section 3.5**, and encompasses activities of seabed preparation, sediment borrow and spoil disposal, installation of the Project pipeline, onshore activities and support vessel movements in the immediate vicinity of the pipelay vessel (accounting for the full extents of anchor handling).

The Project Area has been sub-divided into three key 'areas' relevant to this referral; being:

+ Offshore NT waters (i.e. NT waters outside Darwin Harbour). Note that this includes the proposed location for sediment borrow and spoil disposal;
+ Darwin Harbour (i.e. waters within the Darwin Harbour Management Area); and
+ Shore crossing location (including the short onshore section of the Project pipeline).

The Project Area is shown in **Figure 3-1.**

3.4 Project schedule

Subject to receipt of all relevant regulatory and joint venture approvals, Santos anticipates the decision to proceed with the DPD Project will be taken in Quarter 1 2022. Following this, construction works will commence in Quarter 1 2023. Final pipeline pre-commissioning is expected to be complete by the end of Quarter 2 2024, with first gas from the Barossa Field expected in the first half of 2025. The indicative schedule for key Project activities to meet the Project milestones is presented in **Table 3-2.**

Table 3-2 Indicative Project delivery schedule

Phase		Timing	Indicative Duration
Construction	Surveys	Quarter 4 2022 (i.e. before pipelay activities)	1 month
	Pre-lay works	Quarter 1 2023	15 months
	Pipeline installation and pre-commissioning	Quarter 1 2023	15 months (total over multiple campaigns)
Commissioning and operations		First half of 2025	Projected field life 25 years
Decommissioning		Projected end of life >2050	TBD

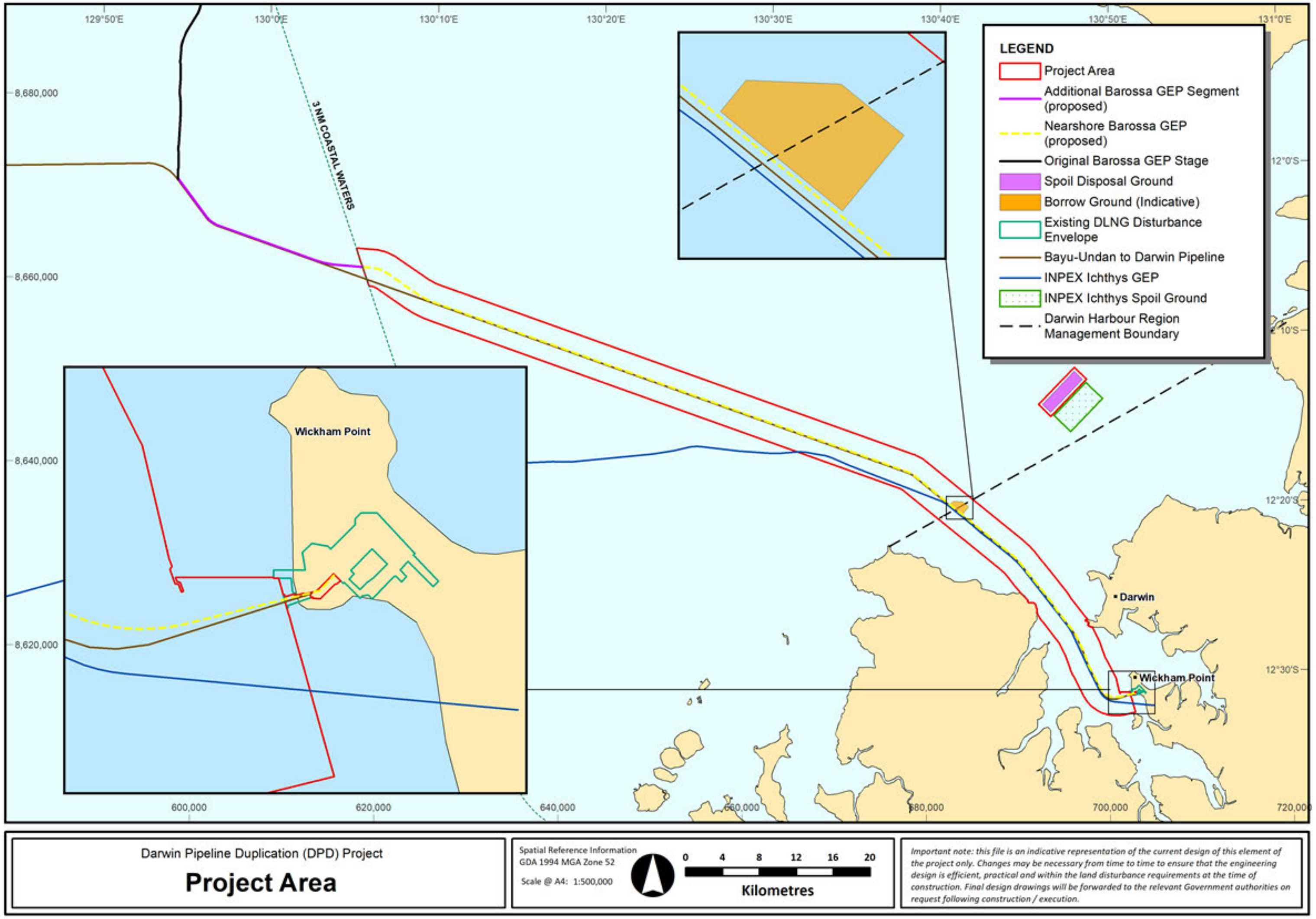


Figure 3-1 Project Area

3.5 Key Project activities

The key Project phases are:

+ Construction
+ Pre-lay works;
+ Pipeline installation and pre-commissioning;
+ Commissioning and operations; and
+ Decommissioning.

Table 3-3 lists all the Project activities as described in this section, along with the locations they are proposed (as defined in **Section 3.3**).

Note that the locations for activities along the Project pipeline are described using ‘kilometre points’ (KP), where KP 0 is the beginning of the Project pipeline from the “pipeline end termination point C” (PLET C) in Commonwealth waters. For this referral the Project begins at the boundary of NT waters at KP 22.26, and terminates at the DLNG facility.

Table 3-3 Location of the different activities associated with the Project

Activity	Offshore NT waters	Darwin Harbour	Onshore / shore crossing	Offshore NT waters spoil disposal ground	Offshore NT waters borrow ground
Surveys					
Offshore surveying	Y	Y		Y	Y
Onshore surveying			Y		
Pre-lay work					
Pre-lay trenching	Y	Y			
Spoil disposal	Y			Y	
Pre-lay span rectification	Y	Y			
Pipeline crossing	Y	Y			
Cable crossing		Y			
Onshore and shore crossing construction			Y		
Pipeline installation and pre-commissioning					
Pipelay activities	Y	Y			
In-line tree	Y				
Pipeline shore pull			Y		
Trench backfill	Y	Y	Y		Y
Post-lay span rectification	Y	Y			
Flood / clean / gauge / testing, dewatering	Unplanned	Unplanned	Y		

Activity	Offshore NT waters	Darwin Harbour	Onshore / shore crossing	Offshore NT waters spoil disposal ground	Offshore NT waters borrow ground
Post-lay trenching		Y			
Commissioning and operations					
Transport of hydrocarbons	Y	Y	Y		
Inspection, maintenance and repair	Y	Y	Y		
Decommissioning					
Pipeline	Y	Y			
Subsea infrastructure	Y	Y			
Onshore			Y		
Support operations					
Vessel operations	Y	Y		Y	Y
Helicopter operations	Y	Y			
Remotely Operated Vehicles (ROV)/ Autonomous Underwater Vehicle (AUV) operations	Y	Y		Y	Y
Onshore equipment operations			Y		

3.5.1 Surveys

Offshore surveys

Site surveys that will be undertaken at various stages throughout the Project include:

- Pre-lay;
- During and following pipeline trenching and installation;
- Routine inspection surveys during operations; and
- Post decommissioning.

A pre-lay survey will be undertaken prior to commencement of pipeline installation and surveys will continue throughout the construction phase, to monitor the activity and evaluate progress of the installation. The pre-lay survey will include bathymetric and geophysical evaluations of the seabed to identify debris and other hazards along the proposed route prior to laying the Project pipeline, noting the initial site investigation did not identify any debris that would require removal prior to installation in offshore areas (RPS, 2021).

As laid and cathodic protection surveys will be progressively undertaken throughout the installation phase and also during subsequent operations, i.e., inspection, maintenance and repair activities. The data from these surveys will be used to determine the Project pipeline position once laid, inform free-span rectification requirements, identify deviations from straightness, etc. Surveys will use the same techniques as outlined above, as well as visual inspection using Remotely Operated Vehicles (ROVs) and cathodic protection equipment such as passive field gradient sensing equipment.

During operations, surveys will be undertaken as a part of ongoing inspection and maintenance. As-left surveys may also be conducted as part of future decommissioning activities.

Surveys will be undertaken either from dedicated survey vessels, or other support or installation vessels. ROVs or autonomous underwater vehicles (AUV) may be used during surveys, using visual or geophysical techniques (such as side scan sonar).

Methods that will be used to undertake the offshore surveys include:

- Geophysical surveys –
  - Geophysical marine survey methods for identifying debris, seabed features, buried assets (i.e. fibre optic cable) and obstructions are non-intrusive, and the equipment does not disturb the seabed. Survey methods will primarily include multibeam echosounder (MBES). MBES uses sound pulses to establish the seabed profile. Most modern MBES systems work by transmitting a broad acoustic pulse from a hull or pole mounted transducer. A sub-bottom profiler (SBP) also uses acoustics, although the acoustic pulse is transmitted from a towed surface or deep-sea source and collected by a receival array that is towed below the water surface.
  - Side scan sonar (SSS) identifies any sea floor debris and seabed profiles. SSS involves towing a set of transducers mounted on either side of a 'tow fish' approximately 10-20 m above the seabed, producing pulses at high frequencies.
- Underwater acoustic positioning
  - Installation of the Project pipeline requires accurate positioning on the seabed and therefore long base line (LBL) and/or ultra-short baseline (USBL) acoustic positioning may

be required. USBL and LBL utilise transponders. Typically, for a USBL array, transponders are installed attached to subsea equipment and recovered once the equipment is correctly positioned on the seabed. For LBL, transponders are typically fixed to seabed frames which are deployed and then fully recovered once subsea equipment is correctly positioned.

  - LBL arrays will be required at the in-line tee location should Santos progress this option. The footprint on the seabed of a typical LBL transponder frame is less than 5 m^2 per frame, giving a total of ~240 m^2 seabed disturbance. LBL and USBL systems work by emitting short pulses of medium to high frequency sound. Transmissions are not continuous but consist of short 'chirps' with a duration that ranges from 3 to 40 milliseconds.
  - USBL and LBL will be installed at the site of the in-line tee before installation of foundations (up to 1 month prior). The array will then be set up to guide foundation installation. Units will be retrieved after installation of the in-line tee.

Onshore surveys

Onshore geophysical and geotechnical surveys will be undertaken prior to construction at the DLNG facility shore crossing location. These survey activities may include:

+ Geophysical, including refraction and multi-channel analysis of surface waves (MASW); and
+ Geotechnical, including digging of test pits with an excavator; PiezoCone penetration test (CPT) testing and core sampling (i.e. to test for acid sulphate soils). These could extend down to the anticipated depth of the trench (i.e. 5 m).

Following decommissioning, surveys will be undertaken of the ground level (as-left survey).

3.5.2 Construction

3.5.2.1 Pre-lay works

For deep-water sections of the Project pipeline, the pipeline will be laid directly on the seabed. Given pipeline stability is improved when the pipeline can be placed as flat as possible, some seabed intervention will be required as part of pre-lay rectification and or stabilisation activities.

In shallower waters, the Project pipeline will require stabilisation due to exposure to waves, currents and tidal movement, and may need impact protection from third-party activities (i.e. anchors). As such, in some areas the Project pipeline will be installed in a trench in the seafloor to protect it from such instabilities and activities.

Pipeline pre-lay trenching

While the carbon steel construction and concrete coating provides some protection to the Project pipeline from external impacts, in shallower waters other techniques are proposed for protection. A key technique will be to trench the Project pipeline, and following pipelay, backfill the trench using rock or other material sourced from the offshore borrow ground. The expected volume of rock placement material is estimated to be 200,000 tonnes, with a maximum volume of no more than 500,000 tonnes in the event of over dump or contingency scenarios.

It is likely trenching may be required in both the Darwin Harbour (i.e. nearshore) and shore crossing locations.

Trenching

The pre-lay trenching associated with the Project pipeline installation involves the excavation of a trench along the pipeline route within an indicative trunkline corridor of 50 m width. Trailer Suction Hopper Dredges (TSHDs), Cutter Suction Dredges (CSD) and Backhoe Dredges (BHDs) have been proposed for the pre-lay trenching works. Material will be excavated and disposed of at the spoil disposal ground, as shown in **Figure 1-1**.

Closer to shore, it is expected that BHDs will be used. The BHD will be supported in shallow waters on spuds and will empty spoil onto split hopper barges. These barges are self-propelled or towed to the spoil disposal ground, where barges 'split' and spoil is released.

Locations of proposed trenching along the pipeline are shown in **Figure 3-2.**

Trenching from onshore

Excavators may be used from onshore to dig the trench through the shore crossing at the DLNG facility. To support this, some temporary shoreline modifications may be required, including the construction of a cofferdam using sheet piling to help retain trench walls and / or a temporary groyne so the excavators can operate further from the current shoreline. The temporary groyne would be built with imported rock and fill and pushed out with the tide.

Experience from the original Bayu-Undan to Darwin pipeline shore crossing works identified that the intertidal zone had potential to contain Acid Sulphate Soils (ASS). Some of the material excavated during the crossing construction was shown to be ASS, which if left exposed to the air would have required treatment with lime. However, the ASS material recovered at the shore crossing was placed below the waterline so no treatment was ultimately required.

If ASS or Potential Acid Sulphate Soils (PASS) are identified during trenching activities, the main approach to manage these will be to keep the ASS/PASS material submerged, alongside the trench within the existing pipeline disturbance footprint or disposed of at the spoil disposal ground. If this is not possible, ASS will be removed and stored onshore and treated with lime or other approved neutralising chemicals. ASS material may be used as backfill after treatment onsite with lime. If it is not suitable for re-use, it will be removed from site for either re-use or disposal at an approved location (including the spoil disposal ground).

Further context of ASS potential is provided in **Section 7.1.4.2**.

3.5.2.2 Spoil disposal

Trenching for the Project pipeline installation will result in the requirement to dispose of an estimated 250,000 $m^3$of spoil however a contingency of 750,000 m^3 has been considered. The proposed spoil disposal ground for trenched material is located to the north of Darwin Harbour, within the Beagle Gulf, approximately 12 km north-west of Lee Point. This location has been selected with consideration of technical, environmental, cost and safety aspects and available information. The selected site is adjacent to the spoil disposal ground approved for use by INPEX for the Ichthys Gas Field Development Project (refer to **Figure 3-1**).

While the majority of the spoil material will be disposed of within the spoil disposal ground, there may be materials that are side cast (placed adjacent to the excavation of the trench on the shoulders) and reused for backfill.

Santos

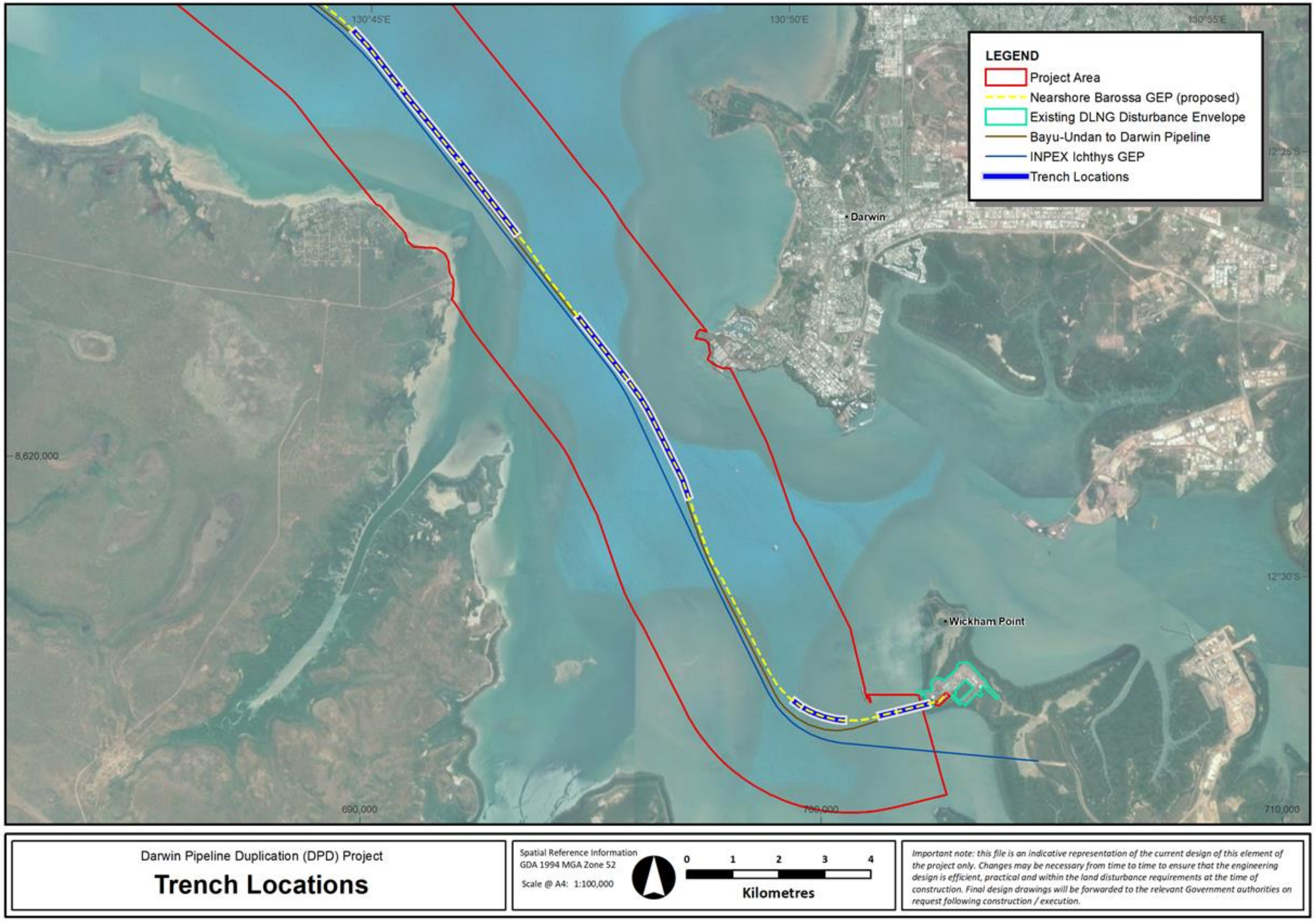


Figure 3-2 Nominal trench locations

3.5.2.3 Pre-lay span rectification and foundation installation

Following the pre-lay survey, an assessment of the span rectifications required for installing the Project pipeline will be made. In the event that pre-lay span rectification is required, the following activities may be undertaken:

+ Installation of concrete mattresses or grout bags to act as 'bridge' or scour protection around foundations using a construction vessel. Each mattress is 18 m^2 and mattresses may be installed in groups and/or stacked on top of each other; and
+ Sandwave rectification (to stop pipeline spanning) using TSHD or BHD; or by mattress installation. Where sediment is removed, this will be disposed of in the spoil disposal ground, or may be used as backfill for nearshore trenching. The volume of material for this activity would be much smaller than for pre-lay trenching and is estimated to be <30,000-60,000 m^3.

It is expected that approximately 40 pipeline spans will require rectification, with individual span heights less than 1.5 m.

In addition, for the in-line tee, a steel pre-lay foundation may be installed, complete with scour protection in the form of mattresses or grout filled mats, with an approximate footprint of 375 m^2.

3.5.2.4 Pipeline crossings

If the central route is selected as the final Project pipeline route, the pipeline crosses the existing Bayu-Undan to Darwin pipeline between KP 100 and KP 120, with the final location to be determined.

The northern route does not require crossing of any existing pipelines. However, should this be required due to a change in route, different methods may be used to construct the crossing. This includes:

+ Installation of a concrete mattress bridge (base case); and
+ Rock placement should there be a requirement to protect the crossing against overtrawl by commercial fisheries (unlikely in this area) or anchor drag.

If concrete mattresses are to be used, it is estimated that the total footprint of the mattresses over the existing pipeline will be approximately 200 m x 15 m, or 3,000 m^2.

If rock placement is required, the estimated rock footprint over the existing pipeline will be approximately 500 m x 15 m, or 7,500 m^2. The maximum volume of rock based on over dump and contingency scenarios is estimated to be 500,000 tonnes, with an expected volume of 200,000 tonnes.

3.5.2.5 Cable crossings

Telecommunications and power cables in Darwin Harbour will be protected during pipelay operations using concrete mattresses if required. Supports either side of the individual cables will be provided, and it is likely that concrete mattresses will also be used to provide clearance between the Project pipeline and cable.

If concrete mattresses are to be used, it is estimated that the footprint of the mattresses over the four existing cables will each be approximately 12 m x 12 m, or 600 m^2.

For future cables, installation over the Project pipeline will be managed in consultation with the owner/operator of the future cable and Santos.

3.5.2.6 Onshore construction

The proposed method to bring the Project pipeline ashore at the shore crossing is to use a shore-based winch, as the pipeline is welded on the pipelay vessel. The onshore disturbance is located within the existing DLNG facility disturbance envelope, as shown in **Figure 3-3.**

The shore pull location and equipment layout has been designed to accommodate all contingency operations, i.e. wet buckle dewatering while the pull head is attached to the winch wire.

Onshore construction could include:

+ Vegetation clearing;
+ Civil works and grading of the onshore shore pull site location, construction of a levelled lay-down area for the winch foundation;
+ Import of clean fill;
+ Preparation of lay down areas, access roads, hardstand (geotextile and road base) and site fencing;
+ Installation of the winch spread, including winch pad, holdback anchor and/or sheet piling;
+ Installation of bedding rock and or rollers for the shore pull; and
+ Installation of facilities including offices, amenities, chemical and fuel storage, ASS storage and treatment.

The shore crossing location will be used for the flood, clean, gauge, testing (FCGT) scope once the Project pipeline has been fully installed. A hydrotest spread will be installed, with bulk chemical storage. Depending on the hydrotest concept selected, a bladder may need to be installed to temporarily store hydrotest water (i.e. an enclosed bladder within steel retaining wall).

The total area of the shore crossing location (onshore) is approximately 4 Ha and is completely within the existing DLNG disturbance envelope.

Santos

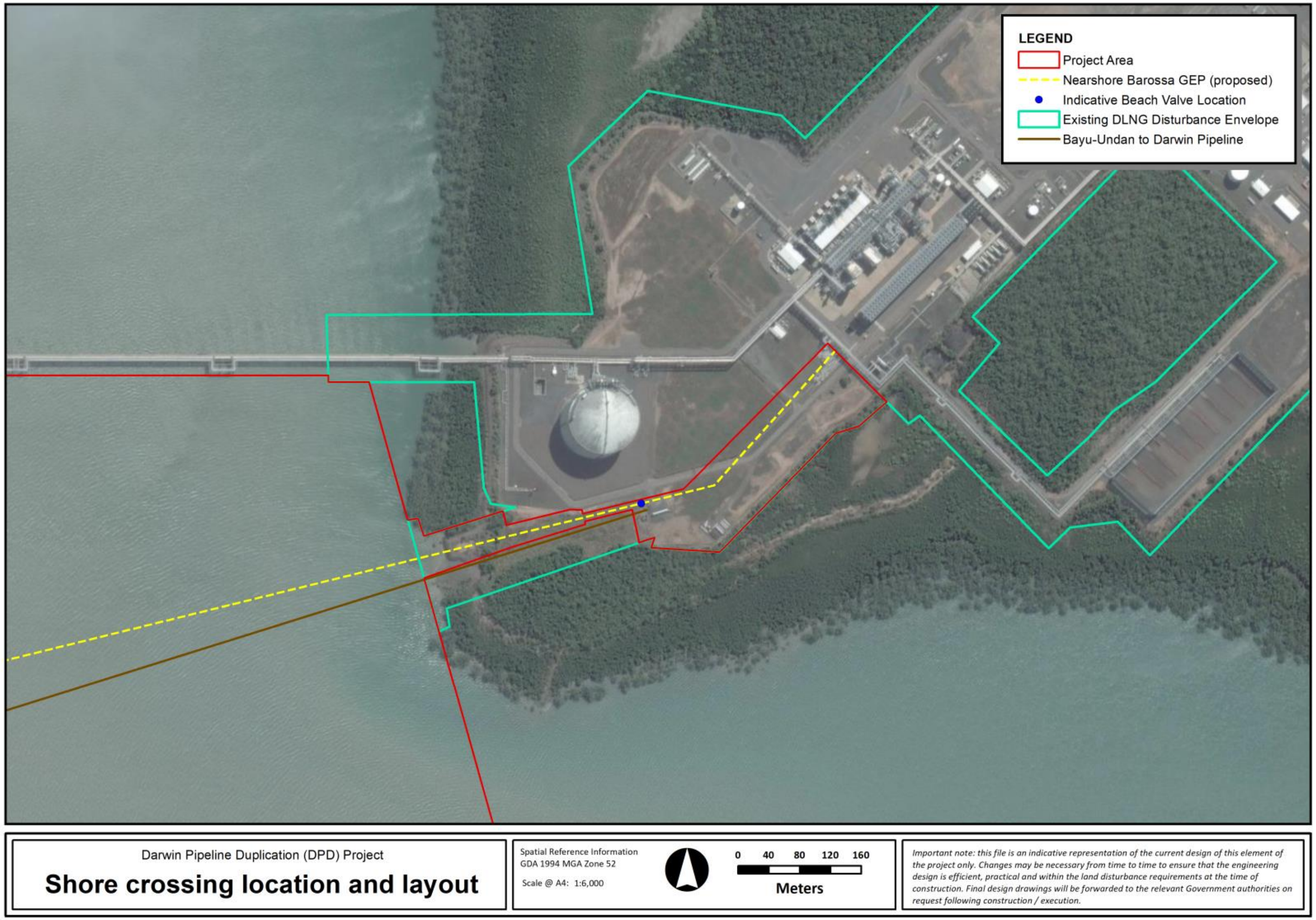


Figure 3-3 Shore crossing location and layout

3.5.2.7 Pipeline installation and pre-commissioning

Pipelay activities

The Project pipeline will be laid using a continuous assembly pipe-welding installation method, which involves the assembly of the single pipe joins (approximately 12 m in length) in a horizontal working plane onboard the pipelay vessel. The pipe joints are welded together, inspected and then the welded area is coated on board the vessel before being lowered behind the pipelay vessel. The pipelay uses an ‘S-lay’ method (with the S notation referring to the shape of the pipeline catenary as it is lowered to the seabed). As the pipeline is lowered, it is supported on board the pipelay vessel using a curved steel structure fitted with rollers known as a ‘stringer’.

The pipelay vessel that will be used is dependent on a range of factors including the availability of vessels, final pipeline parameters and water depth. Both dynamically positioned (DP) and anchored pipelay vessels will be used to perform the installation, dependant on water depth. Examples of pipelay vessels are shown in **Figure 3-4** and **Figure 3-5**.

In the offshore NT waters, the pipeline will be laid at approximately 2 km/day using a deep-water dynamically positioned (DP) pipelay vessel (i.e. anchoring not required). For this ~65 km extent the installation disturbance footprint will be limited to a 50 m wide disturbance corridor due to the use of DP.

In shallower waters within the Darwin Harbour, anchoring will be required and the speed of pipelay will be reduced to ~300-400 m/day, depending on the coordination of other supporting activities (i.e. pipelay barge and shore pull).

For this ~34 km extent within Darwin Harbour, the footprint will include the 50 m disturbance corridor, plus the footprints required for vessel anchoring. It is estimated that each of the 10 anchors has a footprint of ~10 m^2, including chain sweep. Between 10 – 20 anchor moves are expected each day, for a period conservatively estimated as 100 days.

When close to shore, pre-installed onshore anchors may be used. These will be within the proposed shore crossing (i.e. onshore) disturbance footprint. If onshore anchors are used, these anchors have a typical footprint of 5 m x 5 m with an additional 40 m^2 for anchor wire on the seabed.

The base case is for the Project pipeline to be sequentially laid, beginning at the shore crossing and moving through Darwin Harbour. Alternatively, pipelay could occur concurrently using a deep-water vessel and a shallow water lay vessel. In this scenario the shallow water vessel would still commence at the shore crossing to facilitate the shore pull and an above water tie-in would be performed in shallow water (around 20 m depth) within the harbour where the two sections of pipeline meet.

Figure 3-4 Example of pipelaying vessel (offshore)

Figure 3-5 Example of pipelaying vessel (nearshore)

In-line tee

The in-line tee (ILT) will be installed during the pipelay activities by the deep-water DP pipelay vessel. The foundation for the ILT would be pre-installed during pre-lay works (**Section 3.5.2.1**). The ILT is welded into the Project pipeline onboard the pipelay vessel and is laid as part of normal pipelay. A protection frame, approximately 5 m high, would be installed post-pipelay by crane (guided by ROV) on the foundation.

Santos

Pipeline shore pull

Shore pull to bring the Project pipeline onshore, will use a conventional winch operation. The arrangement for the shore pull consists of a winch spread installed on a winch pad and attached to a hold back anchor located onshore.

The pipeline pull head on the shallow water pipelay vessel is connected to the winch using a pull wire and suitable rigging. The pipe will be pulled ashore from the pipelay vessel using the winch spread located onshore through the pre-constructed trench, and winched up to ~2 m above HAT.

The pulling arrangement will allow for the shore pull to be completed as a continuous operation, which may take approximately two weeks.

Trench backfill

The primary method of maintaining pipeline stability on the seabed will be through the concrete weighted pipeline coating. It may however also be necessary to install localised secondary stabilisation/protection for sections within Darwin Harbour where the concrete weighted coating alone is not considered sufficient to provide stability and/or protection. Backfilling will be required at the nearshore and shore crossing to maintain pipeline stability.

There are two options for pipeline stabilisation and protection:

+ Rock placement – likely via fallpipe vessel (FPV) or side dump vessel (SDV); self-propelled dynamically-positioned vessels that are used to install rock (sourced onshore) the seabed with support barges used to transport rock. BHD shall also be used to install rock in shallow water at the shore crossing with the rock being bought alongside the BHD on barges; and
+ Engineered backfill – collected and transported from a designated borrow ground using a TSHD vessel and placed on the pipeline via a lower trailing head ~5 m above the pipeline.

Post-lay span rectification

In order to provide pipeline stability, post-lay span rectification may be required and if so, would be undertaken by the installation of grout bags using an ROV. The likely disturbance footprint for each occasion of post-lay span rectification is 25 m^2.

The actual locations would not be known until after the Project pipeline is laid and surveyed.

Flood / Clean / Gauge / Testing (FCGT) and dewatering/pre-commissioning

Once installed, the Project pipeline internal surfaces need to be cleaned, tested and preserved in preparation to carry hydrocarbons. This is conducted through pigging. A series of pigs (inspection gauge used to manage liquid accumulation) will be pushed through the pipeline to clean the pipeline, gauge the pipeline and ensure all air is removed during the flooding process. Pig launcher/receivers (PLRs) will be installed on the pipeline end termination point 'C' (PLET C) in Commonwealth waters and at the shore crossing. The pigs are pushed using chemically treated seawater with water sourced from either Darwin Harbour (if the pig will be pushed from onshore to offshore) or offshore in Commonwealth waters (if the pig will be pushed from offshore to onshore). Water will be screened at the intake to reduce the risk of harm to marine fauna.

The chemically treated seawater is typically a mixture of biocides (to prevent biofouling and bacterial corrosion on the internal surfaces), an oxygen scavenger (to control corrosion of the pipeline) and a dye (for leak detection during hydrotest).

There is no planned discharge of FCGT fluids in NT waters. Discharges are limited to Commonwealth waters and will be in accordance with the relevant environmental approvals.

While the current planning is to dewater the entire Project pipeline in one go as described above, if there is a failure in the pipeline during installation that requires remedial construction work on the pipeline, or if a pipeline wet buckle occurs during pipelay (a wet buckle is when there is a failure in the pipeline during installation which results in the ingress of raw / untreated sea water into the pipeline), contingency plans will be implemented. Refer pipelay contingencies below for detail.

Post-lay trenching

Following pipelay, some additional trenching may be required to locally lower the Project pipeline. Post-lay trenching will be undertake using a 'plough' or mechanical rock trencher which, when lowered over the pipe, cuts a trench underneath it. This method would only by undertaken within the Darwin Harbour, outside of locations where the sand waves occur. This method is not base case, and the requirement and location would not be known until after the pipe is laid.

Pipelay contingencies

While unlikely to occur, failures in the Project pipeline and the occurrence of wet buckling can occur during pipelay activities and in these situations, pipelay contingency activities will be required.

A 'wet buckle' event may occur during installation should the pipeline become buckled and fracture during pipelay, resulting in flooding of the pipeline with raw, untreated seawater. If this occurred, the raw seawater will need to be removed from the pipeline to prevent corrosion to the undamaged section of pipeline. To remove the raw seawater, a contingency pig is launched with filtered seawater to flush the pipeline, followed by a second contingency pig which is pushed with compressed dry air. The pipeline end is then recovered and pipelay can continue.

If there is going to be an extended period before pipelay can recommence, then the pipeline will be flushed with raw filtered seawater and then filled (from the DLNG facility end) with inhibited seawater to safely preserve the pipeline in the intervening period before pipelay is recommenced. In this instance the inhibited seawater will be treated with chemicals to preserve the pipeline. If preservation is required, there is the potential for some of the inhibited seawater to be discharged as a result of overpump which is required to make sure the entire previously laid pipeline is preserved to prevent corrosion.

While this is an unlikely event, it has occurred elsewhere and as such for assessment purposes a conservative contingency volume of less than 600 m^3 of discharge has been applied as a result of an overpump.

If a wet buckle occurs during FCGT, these fluids may be discharged at the location point, which may be in NT waters. As above, a conservative volume of less than 600 m^3 of discharge has been considered with an additional 300 m^3 to be collected onshore in a bladder and discharged within Commonwealth waters at PLET C.

Demobilisation at shore crossing

Following the completion of shoreline construction activities (i.e. shore pull and winch spread) and pre-commissioning activities, the pipeline will be backfilled with the remaining 20-30 m (at the DLNG end) left in the ground unburied for a period of time ready for tie-in. Fauna entrapment risks will be managed under the Construction Environmental Management Plan (CEMP). As a separate campaign, Santos will then install the remaining 800 m section of trenched pipeline (including the beach valve and piping inside the DLNG plant) to the DLNG plant tie-in point. Following these works the pipeline trench will be completely backfilled, and the site returned to an agreed condition, with removal of hardstand and geotextile. The plant tie-in works is outside the scope of this referral.

3.5.3 Operations

The activities associated with the operations phase include:

+ Commissioning and transport of dry hydrocarbons through the pipeline; and
+ Inspection, maintenance and repair of the installed infrastructure.

Operations and maintenance of the Project pipeline is expected to follow the same, or very similar management procedures and risk-based approach currently used by Santos to operate and manage the Bayu-Undan to Darwin pipeline.

3.5.3.1 Transport of hydrocarbons

The principal activity during operations of the duplicate pipeline will be the flow and transportation of natural gas from offshore reservoirs to the DLNG facility. There will not be a separate control system for the pipeline and therefore valve discharges will not occur within NT jurisdiction.

3.5.3.2 Inspection, maintenance and repair

Inspection, maintenance and repair (IMR) of subsea and onshore infrastructure will be undertaken to ensure that the integrity of the hydrocarbon system is maintained at acceptable standards. IMR activities will typically be vessel based, and may occur at any time.

Offshore, subsea inspections using ROV/AUV may include but is not limited to:

+ Cathodic protection surveys; and
+ General visual inspections.

Typical offshore IMR activities include:

+ Anode replacement;
+ Cathodic protection system maintenance;
+ Pipeline / spool repairs;
+ Span rectification and pipeline stabilisation, i.e. grout bags;
+ General subsea infrastructure servicing (includes leak testing);
+ Marine growth removal;
+ Removal of fishing nets or other marine debris; and
+ Re-commissioning (similar to pre-commissioning discussed in **Section 3.5.2.7**).

In the unlikely event of pipeline failure, the pipeline may need to be repaired, which involves similar activities to decommissioning, and pre-commissioning (refer to **Sections 3.5.4** and **Section 3.5.2.7**).

Typical onshore IMR activities include:

+ Cathodic protection surveys (visual, electrochemical potential survey);
+ Fugitive leaks (gas sampling);

+ General visual inspections for damage and missing items; and
+ Wall thickness measurements (ultrasonic testing).

Typical maintenance and repairs undertaken which may also have an environmental impact include:

anode replacement;

+ Cathodic protection system maintenance;
+ Pipeline / spool repairs; and
+ Re-commissioning (similar to pre-commissioning discussed in **Section 3.5.2.7**).

3.5.4 Decommissioning

At the end of the Project, it is expected that pipeline hydrocarbons will be displaced to the DLNG facility and the pipeline will be flushed with either raw seawater, air or nitrogen. The Project pipeline and associated facilities will then be decommissioned in accordance with regulatory requirements at that time.

The DLNG facility and existing Bayu-Undan to Darwin pipeline have existing conditions of approval for a future decommissioning plan. It is expected that the Project will be considered within this plan and/or a separate Project decommissioning plan.

3.5.5 Summary of Vessel and Support Activities

Support activities associated with the Project will be undertaken throughout all phases of the Project. Support activities are likely to include, vessels, helicopters, ROVs, and onshore equipment, with varying requirements depending on the Project phase.

3.5.5.1 Vessel activities

A number of vessel types will be required to complete the proposed activities, including:

+ Marine survey vessels - to support pre-lay and post lay surveys of the Project pipeline, including trenching scope and spoil ground;
+ Pipelay vessels – to install the pipeline;
+ Construction vessels – to support installation of structures (i.e. PLET foundations, mattresses for scour protection, mechanical protection and stabilisation etc);
+ Rock placement vessels – including fall pipe vessels, side dump vessels and non-propelled barges;
+ Excavation vessels – including cutter suction dredgers (CSD), trailer suction hopper dredgers (TSHD) and backhoe dredgers (BHD); and
+ Supply vessels – to provide general support and supplies to all offshore activities.

Activities occurring on the vessels while onsite include:

+ Bunkering / bulk transfer of fuel, chemicals, and supplies to facilities;
+ Transfer of waste from vessels to shore;
+ Discharge of:
  - Sewage, greywater and food waste;

  – Cooling water and reverse osmosis (RO) brine; and
  – Deck drainage and bilge.
+ Atmospheric emissions from power generating equipment, including engines and generators;
+ Vessel positioning; and
+ Anchoring.

Supply vessels are expected to operate from local regional ports (i.e. Darwin) to transport fuel, stores, waste and specialist supplies such as rock, pipe etc.

Bunkering (re-fuelling) of the vessels may take place either at sea (i.e. if required for the pipelay vessel) or in port (support and other vessels).

Vessels will vary in length, draft and number of persons on board. They may anchor depending on water depth, with varying anchor requirement and disturbance footprints however, sensitive areas will be avoided for anchoring disturbance.

The greatest number of vessels are required during the construction phase, which is expected to take approximately 15 months.

During the operations phase, vessels will only be required for intermittent activities, with the frequency dependant on the IMR schedule.

The expected requirements for support vessels are presented in **Table 3-4.**

Table 3-4 Expected support vessel requirements

Support Activity type	Construction			Commissioning and Operations*
	Survey	Pre-lay Works	Pipeline Installation and Pre-commissioning	
Survey vessel	✔	✔	✔	
Supply vessel		✔	✔	
Pipelay vessel			✔	
Construction vessels		✔	✔	
Rock placement vessels			✔	
Excavation vessels		✔		
Commissioning support vessel				✔

**Note if major repair is required during Project life, then similar vessels to construction may be required.*

3.5.5.2 Helicopter activities

Helicopters are the primary means of transporting passengers and/or urgent freight to/from the pipelay vessel and construction vessel during offshore installation and pre-commissioning activities.

They are also the preferred means of evacuating personnel in the event of an emergency. Helicopter support will be principally supplied from Darwin Airport. Helicopter operations will be approximately three days per week, with typically two flights each day. Helicopters will operate during daylight hours unless in the event of an emergency.

3.5.5.3 ROV / AUV activities

Throughout the Project, offshore activities will be supported by remotely operated vehicles (ROV).

The ROV can be fitted with various tools and camera systems that can be used to capture permanent records of the operations and immediate surrounding environment.

An Autonomous Unmanned Vehicle (AUV) may also be used during IMR activities undertaken during operations.

3.5.5.4 Onshore equipment activities

Shore crossing construction and/or shore pull will require mobile equipment, for tasks such as:

+ Clearing vegetation;
+ Trenching (from onshore);
+ Civil works;
+ Installation of ancillary facilities (site offices), hydrotest spread, chemical and fuel storage, amenities etc;
+ Installation of cofferdam (if required);
+ Installation of hold back anchor(s); and
+ Decommissioning and rehabilitation.

The types of equipment expected to be used include:

+ Light vehicles;
+ Mobile equipment such as excavators, graders, trucks, fuel trucks, etc; and
+ Heavy equipment such as cranes.

3.6 Resource requirements and access

Other components required for the Project are likely to include:

+ Personnel will be required during the construction period. Labour will be recruited from the domestic and local labour market where possible, this is subject to the contractors' resourcing requirements at the time. Accommodation will be provided for the workforce within the Darwin area;
+ Power will likely be supplied by onsite generators to support construction amenities and operation of equipment;
+ Water usage including for dust suppression, washdown facilities and ablutions supply will likely be sourced from mains water supply within the DLNG facility, or provided as self-sufficient water through containerised water trucks; and

- Access to the shore crossing location (i.e. onshore site) will be via the existing DLNG access at the end of Middle Arm Peninsula into Wickham Point.

3.7 Fuels and chemicals

Chemical and fuel storage will be stored onsite within the shore crossing location and may include self-bunded fuel storage/tanks. Fuel trucks will likely be used to supply fuel to construction equipment including excavators, graders, cranes and generators. Hydrotest chemicals will also be stored onshore within a hydrotest spread (i.e. biocides, oxygen scavenger and dye).

3.8 Emissions and discharges

Construction of the Project will produce the following wastes and emissions:

- Vessel wastes including sewage, greywater, food waste, cooling water and RO brine, deck drainage and bilge;
- Atmospheric emissions from power generating equipment (i.e. engine and generators) including greenhouse gases (i.e. carbon dioxide equivalent (CO2-e) emissions);
- Contingency discharge of FCGT fluids (in the event of an unplanned wet buckle only); and
- Trench spoil (offshore and potentially onshore ASS).

4 Stakeholder Engagement

Stakeholder engagement is an essential process supporting environmental impact assessment as it provides potentially affected and interested stakeholders information about the Project's potential impacts and benefits. It also provides the opportunity to communicate any concerns which will be taken into consideration during the Project design and execution. Meaningful stakeholder engagement supports the early identification of issues, addresses community concerns and expectations, and leads to better decision-making and outcomes.

The purpose of this section is to provide a summary of the stakeholder analysis and approach to consultation that has been conducted to date, based on a Project Stakeholder Engagement Plan (SEP) (refer to **Appendix C**). The SEP has been developed to meet the requirements under the EP Act and the NT EPA's guidance for proponents: Stakeholder engagement guidance (NT EPA, 2021c).

The SEP aims to achieve desired outcomes by:

+ Creating a structured process focused on:
+ Building trust and mutual understanding between Santos and Project stakeholders;
+ Addressing statutory stakeholder consultation requirements; and
+ Meaningfully engaging with stakeholders, specifically with regards to the environmental assessment and approvals process.
+ Providing opportunities for Santos to understand stakeholder values and expectations;
+ Embedding the importance of using local contractors and employees as much as possible throughout the Project;
+ Ensuring that Traditional Owners and Indigenous groups are engaged wherever possible;
+ Securing stakeholder feedback that will be used as input for the environmental assessment process and to inform Santos' longer term activities and community involvement; and
+ Aligning with Santos's corporate approach to stakeholder engagement.

4.1 Pre-referral engagement

Targeted stakeholder consultation for the Project has been undertaken as part of the preparation of this referral, and inputs have informed Santos' understanding of stakeholder interests, issues and concerns.

Key stakeholders consulted prior to the submission of this referral are outlined in **Table 4-1**. In parallel, Santos has also been consulting with key stakeholders in regard to the Commonwealth waters section of the DPD Project, as a separate but complementary engagement process. This includes engagement with the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA).

Table 4-1 Key stakeholders consulted

Sector	Stakeholder
NT Regulators / Agencies	+ NT EPA + Department of Environment, Parks and Water Security + Department of Chief Minister and Cabinet + Department of Industry, Tourism and Trade (Fisheries) + Department of Industry, Tourism and Trade (Energy) + Department of Industry, Tourism and Trade (Tenure) + Department of Infrastructure, Planning & Logistics + Aboriginal Areas Protection Authority (AAPA) + NT Heritage Commission
Port and Representative Bodies	+ Darwin Port Corporation + Darwin Harbour Advisory Committee
Indigenous Groups / Representative Bodies	+ Aboriginal Areas Protection Authority (also noted as agency above) + Northern Land Council + Tiwi Land Council + Tiwi land-owner groups + Wickham Deed Reference Group
Environmental Group Representatives	+ Environment Centre NT
Fisheries Representatives	+ Northern Prawn Fishery + NT Amateur Fishers Association + NT Seafood Council
Other Industry / Operators	+ Sun Cable + Tiwi Resources Pty Ltd + INPEX + DLNG Pty Ltd + Sea Darwin

A full consultation register is provided in **Appendix C**. Feedback has been used to inform the referral and key considerations to be taken into account by Santos as part of the management framework. In summary, the common issues raised were as expected with a number reflecting those managed by Santos on an ongoing basis as part of its Northern Australian operations. They include:

+ Impact of the proposed activities on marine fauna and habitat;

- Impact of the proposed activities on water quality;
- Impact of the proposed activities on areas of cultural and indigenous heritage;
- Impact of the proposed activities on those of other marine and harbour users;
- Co-ordination of the proposed activities with other proposed works in Darwin Harbour in order to mitigate cumulative impacts on the above; and
- Ongoing and detailed consultation with other marine and harbour users at every stage of the Project.

Santos has developed a thorough understanding of these issues over many years, and through the implementation of the Project SEP (**Appendix C**) Santos will continue to engage with stakeholders to manage such issues.

4.2 Ongoing engagement

Santos recognises that stakeholder engagement is an open dialogue that continues through the full project lifecycle. The SEP will continue to be implemented on an ongoing basis, to ensure stakeholders remain informed and have opportunities to raise and discuss their interests, issues and concerns. This will allow Santos to take this regular feedback into account in decision-making and project execution.

Specific to this referral, there are opportunities for public comment as part of the referral process and subsequent assessment phases. Santos commits to assessing and responding to public comments as requested.

5 Site Selection and Alternatives

5.1 Development of the Project pipeline corridor (site selection)

Santos is investigating the re-purposing of the Bayu-Undan facilities for Carbon Capture and Storage (CCS) in the Timor Sea. The Bayu-Undan Joint Venture has signed a Memorandum of Understanding (MOU) with the Timor-Leste regulator Autoridade Nacional do Petróleo e Minerais (ANPM) to pursue Carbon Capture and Storage (CCS) by the Bayu-Undan Joint Venture.

Should CCS at Bayu-Undan prove viable and be pursued by Santos, a duplicate pipeline into the DLNG facility would be required to allow continued supply of gas into the DLNG facility. The outcome would allow ongoing operations and production of LNG to supply growing energy demand, and disposal of carbon dioxide from DLNG for CCS.

The consequences of not progressing the Project to install and operate a duplicate pipeline into DLNG within the proposed time frames is that the CCS project may not proceed or would be delayed at a significant additional cost. CCS is recognised by the International Energy Agency, Intergovernmental Panel on Climate Change and the Australian Government as technology to achieve the world's climate goals, and Santos believes this Project should be progressed.

5.2 Assessment of the pipeline corridor (site selection)

During the concept definition phase, Santos evaluated three key pipeline corridor options, as shown in **Figure 5-1.**

+ Gunn Point corridor;
+ Darwin Harbour corridor; and
+ Cox Peninsula corridor.

The Cox Peninsula pipeline corridor option was eliminated early in the assessment because of the length of onshore pipeline required (116 km) to the DLNG facility, potential for land clearing, and uncertainty of heritage impacts. [redacted]

The Gunn Point and Darwin Harbour pipeline corridor options underwent further evaluation to assess and compare the environmental, social and economic advantages and disadvantages, as shown in **Table 5-1**. The evaluation included a comparison of the two corridors for potential impacts to the physical environment, the biological environment, marine fauna of conservation significance and socio-economic and cultural aspects, including heritage and protected areas and the potential to impact other users.

The Darwin Harbour corridor was selected as the preferred option as it eliminates the requirement for a 71 km onshore pipeline which has potential for additional environmental and economic impacts. Darwin harbour has some significant environmental and heritage sensitivities, however these are well understood and can be managed with similar controls to previous gas pipeline projects (i.e. Bayu-Undan to Darwin pipeline and Ichthys pipeline). Furthermore, the Darwin Harbour corridor predominantly follows the existing Bayu-Undan to Darwin pipeline and the Ichthys pipeline into Darwin Harbour reducing interaction with undisturbed areas.

The 'do nothing' alternative would result in discontinuation of production from the DLNG facility and is not considered to be acceptable.

Table 5-1 Analysis of corridor options

Option	Advantage	Disadvantage
Gunn Point	+ Shorter vessel campaign than required within Darwin Harbour + No commercial shipping or Port activities as with Darwin Harbour + No pipeline crossings required + Seabed features are flatter and less rocky than Darwin Harbour + Avoids rock placement Darwin Harbour	+ Requires long onshore pipeline (nominal 71 km) to connect to DLNG, hence larger potential onshore impacts compared to Darwin Harbour option + Nearby residential stakeholders + Nearshore approach and shoreline crossing would require longer open cut trenching and fill through the shallow water + Seagrass present in nearshore waters at Gunn Point and dugongs present (Palmer and Smit, 2020) + Flatback turtle nesting on Gunn Point beaches likely requiring temporal exclusions + Intertidal flats that act as shorebird feeding grounds + Pockets of monsoon rainforest and presence of mangroves and salt flats + Greater onshore air emissions for a longer onshore pipeline than Darwin Harbour option + Although no BIA, the presence of dolphins has been observed in the area
Darwin Harbour	+ Avoids impacting previously undeveloped areas compared to Gunn Point + Follows the Bayu-Undan to Darwin pipeline and Ichthys pipeline + Small onshore pipeline within existing DLNG disturbance footprint – minimal onshore	+ Trenching and rock placement required + High commercial vessel and port activity in proximity to pipelay activities + Longer vessel campaign than required at Gunn Point + Indigenous Sacred Sites nearby, but avoided

Option	Advantage	Disadvantage
	disturbance compared to Gunn Point + Low prevalence of sensitive benthic habitats, i.e. seagrass and coral + Key sensitivities within Darwin Harbour are well understood from the number of projects operating in the area + Less onshore air emissions than Gunn Point option + Known Aboriginal sacred sites within Darwin Harbour can be avoided as per Ichthys EIS	+ Several shipwrecks within the corridor + Presence of mangroves (but well understood) + BIA of three species of inshore dolphins in the harbour, although evidence from Ichthys EIS that impacts would be minimal + Flatback turtle BIA (although nesting on shoreline within Darwin Harbour not common)

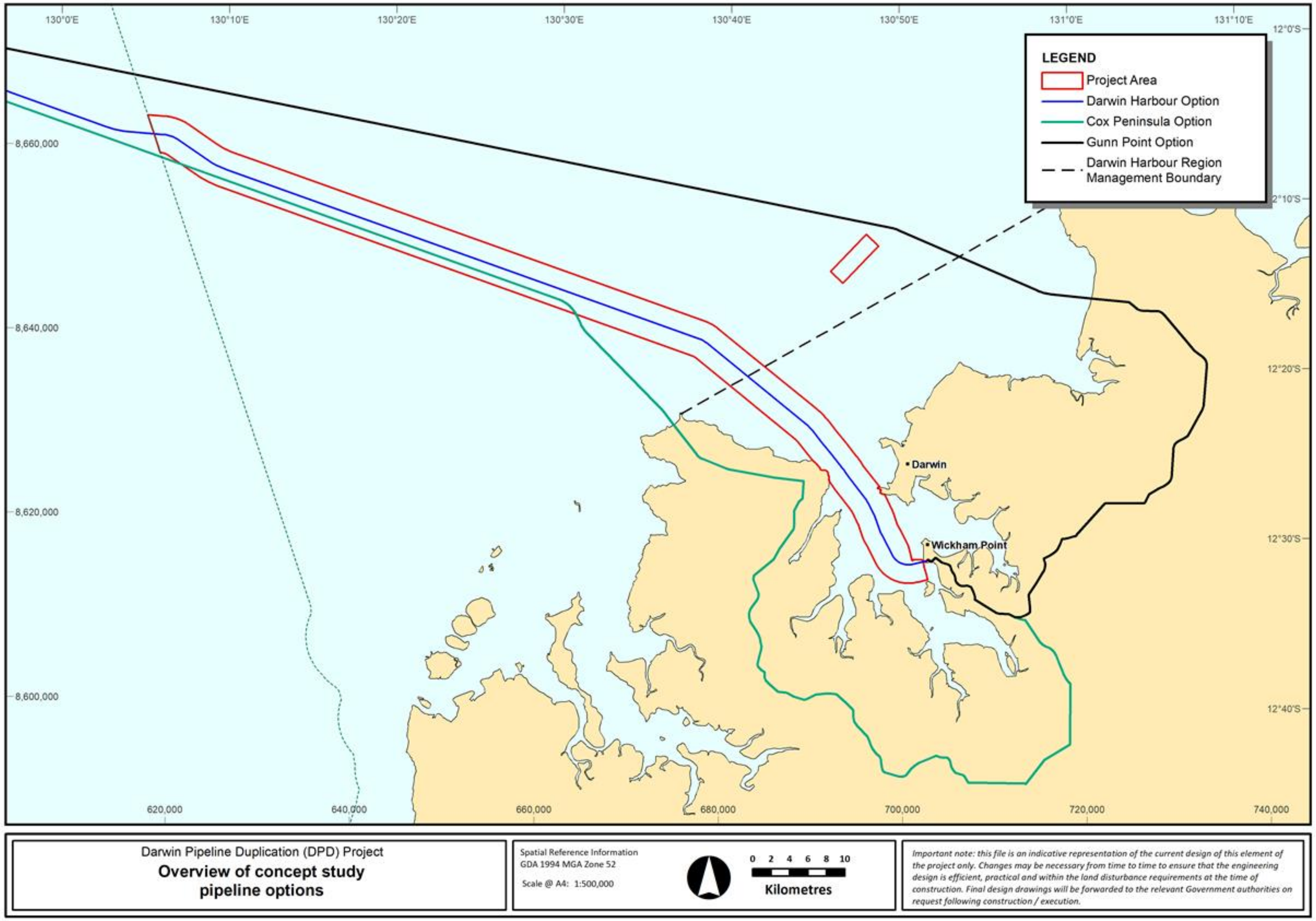


Figure 5-1 Overview of concept study pipeline corridor options

5.3 Darwin Harbour pipeline alternatives

When considering the Darwin Harbour pipeline corridor, Santos considered and evaluated different Project pipeline options though the harbour.

In essence, the Project pipeline could either follow:

+ A northern route – the pipeline would run north-east of the Bayu Undan to Darwin pipeline (nominal separation distance of 100 m);
+ A central route – the pipeline would run between the Bayu-Undan to Darwin pipeline and the Ichthys pipeline. These two existing pipelines have a nominal separation distance of 100 m; or
+ A south-west route - – the pipeline would run south-west of the Ichthys pipeline (nominal separation distance of 100 m).

As a result of the engineering and environmental impact assessment work completed during the concept definition phase, the decision was made to progress with both the northern route and the central route with the northern route being the preferred route, as presented in this referral.

6 Location and Regional Context

As described in **Section 1.1**, the Project minimises environmental and social impacts by utilising the existing pipeline corridor used by the Bayu-Undan to Darwin pipeline and the Ichthys pipeline, with the shore crossing and pipeline termination within the existing DLNG disturbance envelope.

The Project Area has been split into three geographical areas within this referral, for the purpose of describing the existing environment and environmental assessment. These areas are:

+ **Offshore NT waters** – The offshore Project Area extends from the Territorial waters limit, with a typical water depth of between 30-40 m, through to the limit of Darwin Harbour, as shown in **Figure 6-1**. It includes a proposed spoil disposal ground directly adjacent to the existing INPEX Ichthys spoil ground and a borrow ground where engineered backfill may be sourced.
+ **Darwin Harbour** – the Darwin Harbour area of the Project includes the entirety of Darwin Harbour up to the location of the shore crossing as shown in **Figure 6-2**. The Project pipeline within Darwin Harbour follows the route of existing gas pipelines to minimise environmental and social impacts by avoiding disturbance to new locations and reducing interactions with other marine users.
+ **Shore crossing** – the shore crossing location for the Project is within the existing DLNG facility disturbance envelope at Wickham Point within the Middle Arm Peninsula industrial area. The Project Area is within the limits of the existing regulatory approvals for DLNG (i.e. Environment Protection Licence (EPL 217-01) and Exceptional Development Permit (EDP02/0015G)). The existing DLNG disturbance envelope is shown in **Figure 3-3**.

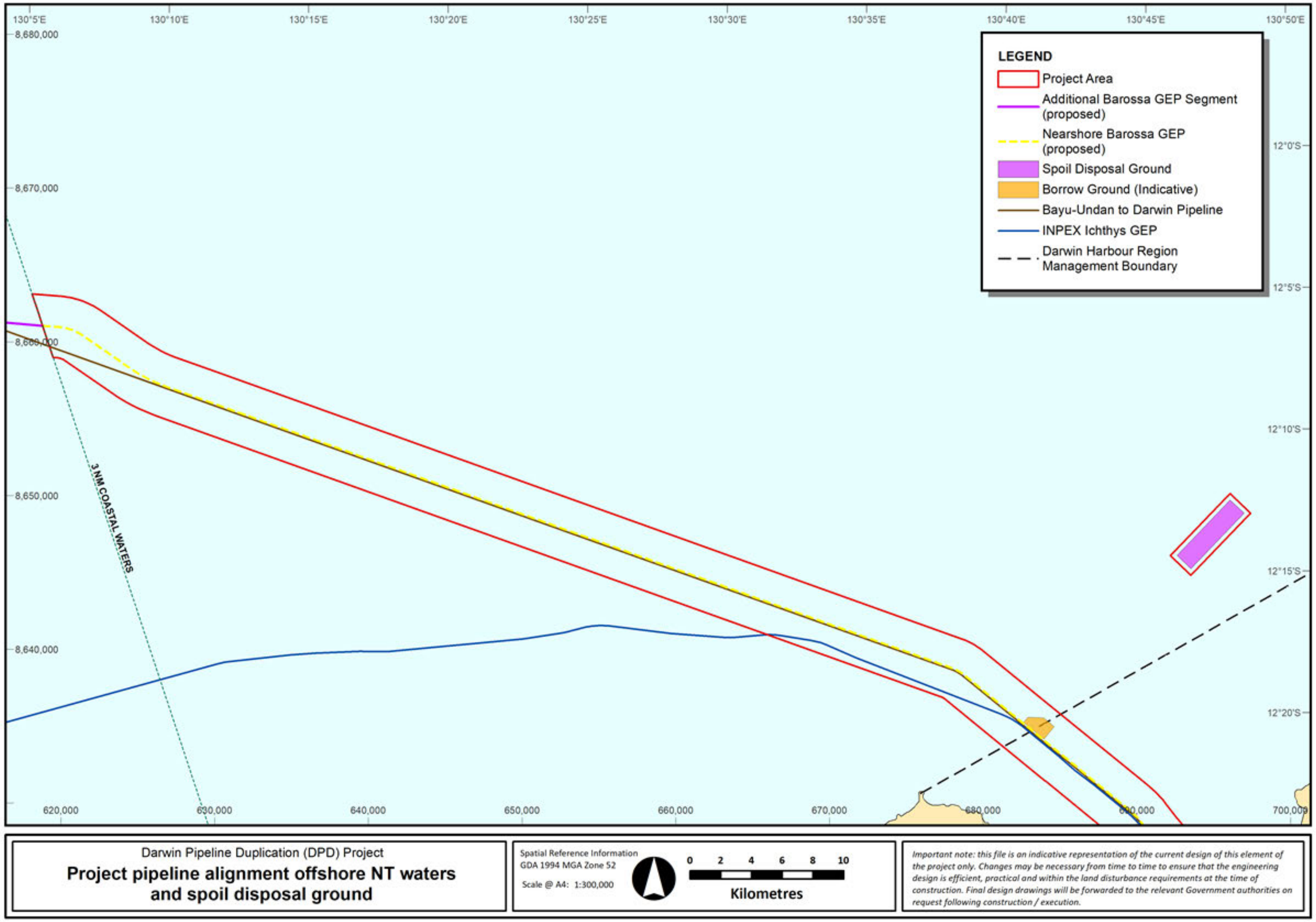


Figure 6-1 Offshore NT waters

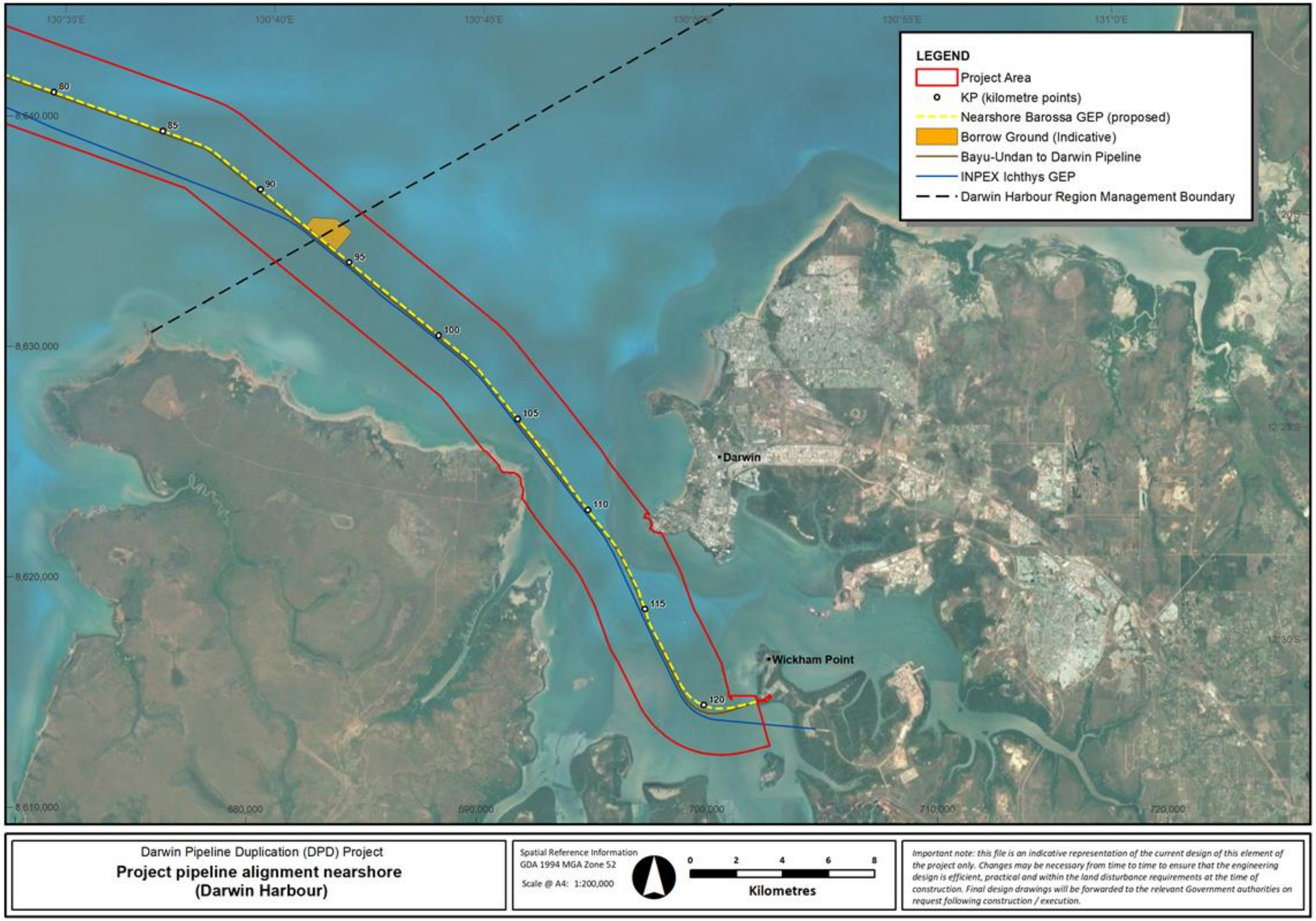


Figure 6-2 Darwin Harbour

7 Existing Environment

This section provides a summary of the existing environmental and social values relevant to the Project by drawing upon the extensive volume of available information that is current and relevant, including:

+ Baseline studies undertaken to support the referral namely:
  - Vegetation assessment undertaken in November 2021 at the shore crossing location (CDM Smith, 2021). The results of this survey effort have been incorporated into **Section 7.3.3.2**; and
  - Baseline marine environmental survey across the Project Area to investigate benthic habitat and gather water quality and sediment quality data (RPS, 2021). The full report is included in **Appendix D**.
+ Australian Government publications including:
  - Material published by DAWE, including Environment Protection and Biodiversity Conservation (EPBC) Act Protected Matters search tool (5km buffer on the Project pipeline) (DAWE, 2021a), species profile and threats database, National Conservation Values Atlas (DAWE, 2021b), biologically important areas (BIAs) and internesting habitat critical to the survival of marine turtles, recovery/management plans and conservation advices, North Bioregional Plan for the North Marine Region and associated conservation value report cards and Australian marine park management plans (DoE, 2015a; b and DoE, 2013).
+ NT publications including:
  - Natural Resource Maps online web mapping tool;
  - Darwin Harbour region report cards (DEPWS, 2019 (various)); and
  - NT Government Darwin Harbour Integrated Marine Monitoring and Research Program (IMMRP) – various publications.
+ Project approvals of relevance to the Project Area and surrounds, including:
  - Darwin LNG Transition Work Program Notice of Intent (NOI) (ConocoPhillips, 2019a);
  - Darwin LNG Environmental Impact Statement (EIS) (Phillips Oil Company Australia, 1997);
  - Ichthys EIS, including the Supplement EIS (INPEX Browse Ltd, 2010a;b, 2011);
  - Barossa Offshore Project Proposal (OPP) (ConocoPhillips, 2018a);
  - Barossa GEP Installation Environment Plan (EP) for pipeline installation (Santos, 2021); and
  - Bayu-Undan GEP EP, for pipeline operations (ConocoPhillips, 2019b).
+ Technical studies, modelling and reports of relevance to the Project Area and surrounds, including, but not limited to:
  - Ongoing operations monitoring relevant to DLNG facility, including mangrove monitoring program, groundwater monitoring and jetty outfall monitoring;
  - INPEX Ichthys monitoring and management plans;

- Technical Report: Darwin – Bynoe Harbours predictive mapping of benthic communities (Galaiduk, 2019);
- Technical Report: Characterising Marine Abiotic Patterns in the Darwin-Bynoe Harbour region: Summary report, Physical Environments, Darwin Harbour Mapping Project (Nicholas et al, 2019);
- Developing an integrated long-term monitoring program for Darwin Harbour. Water Quality Pilot Project WP1: Neap Tide Trial (Makarynksa, 2019a);
- Developing an integrated long-term monitoring program for Darwin Harbour. Water Quality Pilot Project WP2: Intra-annual water quality variability (Makarynksa, 2019b);
- Water Quality Objectives for the Darwin Harbour Region - Background Document (Department of Natural Resources, Environment, the Arts and Sport (NRETAS), 2010).
- Development of an Integrated Long-Term Sediment Quality Monitoring Program for Darwin Harbour (Sub-Project SP1a). Background concentrations of metals and metalloids and their relationship to minerology and grainsize distribution in Darwin Harbour sediment (Munksgaard et al, 2020);
- Sediment quality assessment of Outer Darwin Harbour (Radke et al, 2020); and
- Anthropogenic Pressures on Darwin Harbour: An IMMRP Monitoring Plan (Radke and Fortune, 2020).

7.1 Physical environment

7.1.1 Climate

The climate of the Project Area is characterised by a tropical monsoonal climate with a distinct dry season (May to September) and wet season (October to March), separated by a relatively short transition period. The dry season is dominated by dry, cool weather with little rain, low humidity and wide-ranging temperatures. The onset and duration of the wet season varies between years, however most rainfall in the Northern Territory is associated with monsoonal troughs and/or from isolated convective storms (BoM, 2021). High precipitation rates are commonly experienced during storm events in the wet season.

Synoptic winds during the dry season tend to be dominated by the southeast trade winds, while light west to north-westerlies predominate during the wet season. Sea breezes from the northwest occur on most afternoons throughout the year.

Tropical cyclones occur in the Project Area on average about once per year.

7.1.1.1 Temperature and humidity

Based on the Darwin Airport historical data, November is the hottest month with a mean temperature range of 25.3˚C minimum to 33.3˚C maximum. Temperatures remain in a relatively narrow range throughout the year, with mean minimum temperatures varying from 19.3˚C (July) to 25.3˚C (November) and mean maximum temperatures for the same months varying between 30.6˚C (July) to 33.3˚C (November).

7.1.1.2 Rainfall

The average annual rainfall for Darwin is 1,731.2 mm and most of the annual rainfall occurs between November and March (BoM, 2021). The annual rainfall is highly seasonal, varying from 1.1 mm in July to 424.3 mm in January. Relative humidity at 9.00 am varies from 60% in June and July to 83% in January, with respective monthly values of 38% and 37% to 72% at 3.00 pm. High precipitation rates are commonly experienced during storm events in the wet season. Mean daily evaporation ranges from 5.7 mm (in February and March) to 7.9 mm (in October), with an average annual evaporation of 6.7 mm.

7.1.1.3 Wind direction and speed

Synoptic winds during the dry season are dominated by the southeast trade winds, and light west to north-westerlies are most predominant during the wet season.

Mean afternoon wind speeds tend to be stronger than morning wind speeds all year round. Morning wind speed is typically stronger during the dry season, whereas the afternoon wind speed increases during the late dry, build up and wet season periods which is most likely associated with the formation of mid to late afternoon storm cells during this time of the year.

Strong wind gusts can be experienced at any time throughout the year.

7.1.1.4 Sea level rise

Projected sea level rise for Darwin is 0.8 m between 1990 and 2100, at the current rate of 7.2 millimetres (mm) per year (Darwin City Council, 2011). Sea level rise, while incremental will impact on the natural and built environments along the Peninsula (Walsh et al, 2004).

7.1.1.5 Cyclone activity

Darwin and the NT coastline is within a region where cyclones tend to form. On average, there are 7.7 days per season when a cyclone exists in the northern region of Australia. The Gulf of Carpentaria averages two cyclones a year, while the Arafura and Timor Seas average one a year (BoM, 2021). Cyclones which form in the Gulf of Carpentaria tend to be quite erratic in movement, whereas those which form in the Arafura and Timor Seas tend to follow more regular tracks to the southwest. In the northern region of Australia over half the cyclones generated typically move either southwest or southeast into adjoining regions.

7.1.2 Offshore NT waters

7.1.2.1 Oceanography

The offshore NT waters area of the Project traverses two meso-scale bioregions (areas defined by their biological and physical characteristics), namely the Bonaparte Gulf and Anson-Beagle bioregions.

The Bonaparte Gulf bioregion lies predominantly in offshore Commonwealth waters, between the 30 m isobath and the reef complexes of the Oceanic Shoals bioregion, but also overlaps an area of NT coastal waters, south of Bathurst Island. The Anson-Beagle bioregion comprises coastal and inshore Commonwealth and NT coastal waters, from the high-water mark to the 30 m depth contour.

Oceanic currents in the Bonaparte Gulf Bioregion are influenced by the Indonesian Flowthrough and South Equatorial Current and nearshore currents are predominantly westerly during the dry season months (May to September) and easterly in the wet season (October to March). Tides are semi-diurnal (two highs and two lows per day) and vary through the bioregion from an offshore microtidal range (2 to 3 m) increasing to mesotidal range inshore (3 to 4 m).

Within the Anson Beagle Bioregion, the Project Area traverses the Beagle Gulf which is dominated by strong internal circulation and experiences little oceanic interaction. In the dry season there is a general south-westerly drift while wet season circulation is dominated by a north-easterly drift. Tidal ranges in this region are 6 to 8 m (ConocoPhillips, 2020).

The wave climate in Beagle Gulf exhibits a strong seasonality associated with the tropical north-west monsoon that occurs between November and March. The monsoons' north westerly winds blow over the uninterrupted fetch of the Timor Sea, increasing incident wave energy in Beagle Gulf and at the entrance to Darwin Harbour. During the months of April to October, south-easterly trade winds blow across a limited fetch and generate a low energy local wave climate, with wave heights generally below 1.0 m for 90% of the time, and peak wave energy period of about three to five seconds (Nicholas et al, 2019).

INPEX Browse, Ltd (2010a) deployed a bottom mounted Acoustic Doppler Current Profiler (ADCP) in the vicinity of the proposed offshore spoil ground to measure currents at discrete levels throughout the water column. Measurements showed currents flowed over a tidal axis oriented approximately east-west at speeds up to 1 m/s. The data showed marginally larger variations at the surface indicating increased influence of wind forcing on the currents.

7.1.2.2 Bathymetry and seabed features

Bathymetry, geophysical and geotechnical data within the vicinity of the offshore NT waters is well understood, having been investigated as part of multiple surveys associated with the Bayu-Undan to Darwin pipeline and the Ichthys pipeline. A recent survey along the Project pipeline and spoil disposal ground indicated a relatively featureless seabed with depths typically less than 30 m in the offshore NT waters area of the Project. INPEX Browse, Ltd (2010a) reported areas of megaripples and sand waves up to 4.9 m high some of which, fall within the Project Area.

Navigation charts show water depths of between 40 m and 50 m between pipeline KP23 and KP60 before decreasing to 20 to 30 m Lowest Astronomical Tide (LAT) from KP60 to KP 90 (near the Darwin Harbour port limits).

Depths at the spoil disposal ground are around 17 m LAT and show consistent bathymetry contours indicating a flat, featureless seafloor.

The Carbonate bank and terrace system of the Van Diemen Rise, is within 5 km (north) of the Project Area. This Key Ecological Feature which extends over 300 km north of the Project Area and covers approximately 31,278 km^2, is a unique seafloor feature with ecological properties of regional significance. The feature is characterised by terrace, banks, channels and valleys, with variability in water depth and substrate composition considered to contribute to the presence of unique ecosystems in the channels. The feature provides habitat for sponges, soft corals and other sessile filter feeders; epifauna and infauna such as polychaetes and ascidians; flatback and Olive Ridley turtles, sea snakes and sharks. This area will not be directly impacted by the Project.

7.1.2.3 Water quality

Water quality investigations within proximity to the Project Area have been undertaken as part of the following projects:

+ Original Barossa GEP Stage - Water quality was investigated within the Barossa field (seasonal monitoring through 2015) and along the Project pipeline (July to August 2017); including areas proximate to the Project Area in offshore NT waters. Parameters measured included temperature, pH, salinity and dissolved oxygen, turbidity, chlorophyl 'a', nutrients, metal and hydrocarbon concentrations (Santos, 2021).
+ Ichthys GEP - near-seabed temperature and salinity profiles were obtained along the Ichthys pipeline, including within parts of Beagle Gulf near the offshore Project Area, during geophysical and geotechnical surveys in 2008 (INPEX Browse, Ltd, 2010a).
+ Multiple investigations within Shoal Bay (proximate to the spoil disposal ground) – including:
  - Ichthys nearshore environmental monitoring program (NEMP) – water quality monitoring within Shoal Bay before and during Ichthys dredge spoil disposal to establish baseline conditions and monitor for impacts; water quality parameters included turbidity and temperature and include extensive time-series monitoring data sets. Monitoring included suspended solid concentrations in surface waters derived from daily MODIS satellite imagery.

Monitoring at sites in the Beagle Gulf, as part of the Ichthys NEMP, indicated that due to a combination of stronger winds, larger waves, greater rainfall and increased freshwater input into coastal waters during the wet season, suspended sediment concentrations were significantly greater than during the dry season. Highly turbid water in the Gulf during these periods can in turn increase turbidity within Darwin Harbour as a result of water movement associated with tidal exchanges. However, during periods of prolonged high wind and large wave conditions (i.e. during cyclone events), turbidity in shallow coastal zones of the Beagle Gulf can reach up to five times greater than turbidity in Darwin Harbour. This is due to differences in sediment mobilisation rates associated with larger waves in the Beagle Gulf (Buckee et al, 2014).

Sampling for the original Barossa GEP Stage in 2017 did not identify any levels of aluminium, cadmium, chromium, cobalt, copper, nickel and lead above ANZECC & ARMCANZ (2000) dissolved metal trigger values (Santos, 2021). Total recoverable hydrocarbons and benzene, toluene, xylenes and naphthalene were below the laboratory reporting limits at all sites and depths for each season within the Barossa field and along the original Barossa GEP stage. It is expected that result in the offshore NT waters area of the Project would be comparable.

Generally, there was very little change in most water quality parameters recorded between the Barossa surveys, indicating minimal seasonal variation in the area. The same is expected for the Project Area in offshore NT waters.

The Darwin Harbour Region Report Card reports water quality against a set of Water Quality Objectives (WQOs) (DEPWS, 2019) and assigns a grade against four key water quality health indicators (chlorophyl a, turbidity, dissolved oxygen and nutrients). The report card for 2020, and generally for previous years (back to 2010), reports Shoal Bay water quality as 'very good' having met each of the WQO's. Preliminary water quality data collected as part of planned geophysical and geotechnical survey works provides further understanding of baseline water quality in the Project Area.

Water quality investigations included water quality sampling sites (near seabed and near surface sampling, plus water column profiling) at ten sites along the length of the Project pipeline. Additionally, water quality data was collected from seven sites within and proximate to the spoil disposal ground (refer **Figure 7-1**). The results of the survey showed that the total recoverable hydrocarbons (TRH) and BTEXN results were below the limit of reporting (LOR) for all samples along the Project pipeline and in the spoil ground (< 100 µg/L for TRH and < 1 µg/L for BTEX) (RPS 2021). The results of the survey are included as **Appendix D**.

7.1.2.4 Sediment quality

Sediment within the Bonaparte Gulf is reported as relatively uniform and predominately comprising of sand. Within NT coastal waters, sediments are a mixture of gravelly, sandy sediment (Rochester et al, 2007).

Sediment sampling as part of the original Barossa GEP stage was undertaken in July to August 2017 along the southern end of the original Barossa GEP stage in water depths from approximately 80 m to 25 m. Sediment types observed during these surveys were comparable with those found in local and broader regional seabed habitat mapping studies undertaken in the Eastern Joseph Bonaparte Gulf and Timor Sea (Santos, 2021). As such, data are likely to be representative of the offshore Project Area. In general, sediments transitioned from finer sediments in deeper water to coarse sediments (i.e. gravelly sands) in shallow water around the shoals/banks. Sites to the north of Bathurst Island had finer sediments compared to sites further south, likely due to the prevailing current direction which flows along a south-eastward to north-westward axis near the seabed (Jacobs, 2017).

Generally, sites sampled along the original Barossa GEP stage, to the north of Bathurst Island, had higher metal concentrations than those in the southern section (i.e., closer to the DPD Project tie-in) and were likely to be associated with finer sediments observed in this area (Jacobs, 2017).

Total recoverable hydrocarbons and BTEXN were below the laboratory reporting limits at all sites sampled within and near the Barossa gas field (Jacobs, 2015a). The highest concentrations of nitrogen and organic carbon were associated with the deepest sites and the finest sediments (Jacobs, 2015b). Deep water sediment habitats are predominantly depositional, as indicated by their relatively high particle size distribution fines component and nutrient content.

Preliminary sediment quality data in the offshore NT waters of the Project was collected to provide further understanding of baseline sediment quality (RPS 2021). Sediment quality investigations included sampling at 30 sites along the length of the Project pipeline as well as 13 sites within and proximate to the spoil disposal ground. Findings from the survey indicate that the TRH and BTEXN results were below the LOR for all samples along the Project pipeline and in the spoil disposal ground (< 3 mg/kg for TRH and < 0.2 mg/kg for BTEX). PAH analysis was not required. The results of the survey are included as **Appendix D.**

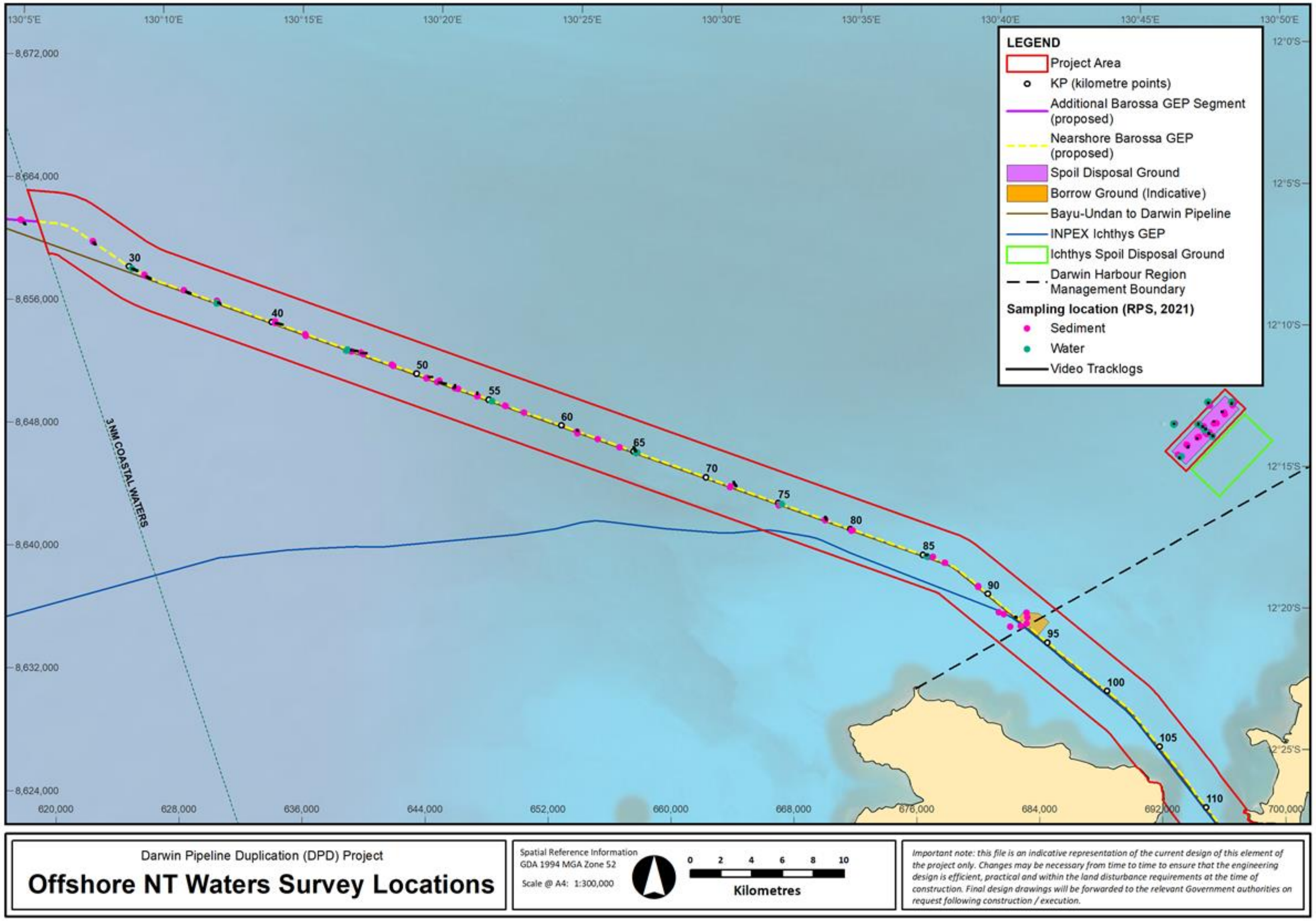


Figure 7-1 Offshore NT waters marine survey locations (RPS, 2021)

7.1.2.5 Baseline noise

There is no ambient underwater noise monitoring data available for the offshore NT waters section of the Project Area. Given the nature and scale of the Project activities, it is considered that site-specific in-field underwater noise monitoring data are not required. Furthermore, noise impacts from activities within the offshore NT waters will be relatively less compared to activities within Darwin Harbour which will involve trenching. It is expected that ambient underwater noise would be minor and typically dominated by vessel noise from commercial fisheries and commercial shipping vessels.

Long-term baseline acoustic monitoring (physical, biological and anthropogenic) for the Barossa Field and surrounding features of interest (i.e. Evans Shoal, Tassie Shoal and Lynedoch Bank) was undertaken to support the Barossa OPP (JASCO, 2016). However, no acoustic monitoring was undertaken within the original Barossa GEP stage, as existing underwater noise sources would be limited to marina fauna callings and vessel movements.

7.1.3 Darwin Harbour

7.1.3.1 Oceanography

Darwin Harbour experiences regular and rapid exchange of water with Beagle Gulf as large tidal movements, and to a lesser extent wind, drive the movement of large volumes of water between inner Darwin Harbour and the Beagle Gulf each day.

The macro-tidal regime of Darwin Harbour has a maximum range of 8.1 m (Harper, 2010) with predominantly semidiurnal tides (two highs and two lows per day), with a slight diurnal inequality. The mean neap tidal range is 1.9 m and mean spring tidal range is 5.5 m (Northern Territory Government, 2011). The lowest spring tides of the year occur during October, November and December and the highest spring tides are in June and July. Tidal excursions range from 8 to 15 km during spring tides and 2 to 8 km during neap tides (Semeniuk, 1985; Hanley & Caswell, 1995).

Circulation within Darwin Harbour results from a complex combination of forces associated with tides, wind, and water density differences and their interactions with coastline, depth and bathymetry characteristic of the harbour. The macro-tidal regime of the harbour is the dominant influence on currents which are strongly correlated with the rise and fall of the tide. Currents in the harbour can peak at speeds of up to 2-2.5 m/s (Williams et al, 2006).

Darwin Harbour is well sheltered from long period tsunami and ocean swell waves by the Tiwi Islands and the harbour’s orientation, shallow bathymetry and coastline configuration. The energy of long period waves entering the harbour quickly dissipates and wave heights decrease significantly. Waves within the harbour are generally of short (3 to 5 seconds) mean periods with heights well below 1.0 m under non-cyclone conditions (INPEX Browse, Ltd, 2010a).

Tropical cyclones can cause extreme wave conditions with significant wave height of 4.5 m and mean wave period of 7.5 seconds at the harbour entrance, which reduce in height down to 0.7 m inside the harbour (GHD, 1997 in Makarynska, 2019). Wave height measurements from the Integrated Marine Observing System (IMOS) National Reference station at the entrance to Darwin Harbour recorded significant wave heights exceeding 3.5m during the passage of tropical lows in 2012 with peak period of wave energy also increasing to between about six to eight seconds (Rigby et al, 2014 in Nicholas et al, 2019).

7.1.3.2 Bathymetry and seabed features

Bathymetry data have been collected as part of several studies completed within Darwin Harbour to form an understanding and characterisation of seabed features. Studies have included:

+ A collaboration between DENR, Geoscience Australia (GA), Australian Institute of Marine Science (AIMS) and the Darwin Port Authority to undertake multibeam bathymetry and backscatter data acquisition for inner Darwin Harbour in 2011. The survey data were processed, analysed and interpreted to produce a series of mapping products describing the seabed characteristics in support of seascape analysis of inner Darwin Harbour.
+ INPEX habitat mapping (inclusive of bathymetry data collection) through a number of areas within Darwin Harbour and Shoal Bay as part of baseline studies for the Ichthys LNG Project in 2011. Bathymetry data was also collected by INPEX as part of dredging studies in East Arm and gas export pipeline installation in the harbour.
+ Recent habitat mapping by Geoscience Australia and AIMS (reported in Nicholas et al, 2019) extending from the intertidal zone to continental shelf depths which resulted in the collection of primary datasets that include high-resolution (1m) multibeam sonar data over 1754 km^2 of the Darwin–Bynoe region (and seabed sediment samples, imagery and videos, and oceanographic data at 453 stations). This information was added to previously collected and interpreted data of the inner Darwin Harbour. Primary datasets of bathymetry and acoustic backscatter, seabed sediment properties (chemistry, grainsize and texture), shallow subsurface profiles, and tidal and current data, were used to derive integrated seabed data products. In turn, these products contribute to the analysis and interpretation of the physical and chemical processes operating in this environment. Derived products include GIS-based 10m grids for seabed rugosity, curvature, slope, geomorphic features, sediment predictions of mud, sand and gravel, sediment chemistry, tidal current velocities, and bed shear stress induced by currents and waves.

Most of the mapped area within Darwin Harbour has water depths between 5 m and 30 m, except for the larger depressions within the estuarine channels. Within the tidal channels in Darwin Harbour, the shallowest water depths are around 1.5 m while the deepest parts of the surveyed area in Darwin Harbour are 41 to 42 m deep and most of the deeper parts of Middle Arm are generally deeper than 30 m. The seabed of Darwin Harbour includes a suite of geomorphological features including sediment dunes and mega-ripples, sandbanks, incised channels, rocky banks and ridges, elevated planar surfaces, and flat-lying sediment plains that include fields of hummocks. However, the harbour is dominated by a large, main tidal channel with adjacent shoreline platforms and subtidal flats (Siwabessy et al, 2016 in Nicholas et al, 2019). The main channel is approximately 36m deep and secondary channels are up to 12m deep (Fortune, 2006). While parts of the channelised seabed are comprised of bedrock, most areas are dominated by unconsolidated sediment forming a wide variety of features including mud flats, ripples, and sub-aqueous dunes. Elongate sand bodies are present seaward of Darwin Harbour and are suggestive of ongoing sediment transport out of Darwin Harbour (Nicholas et al, 2019).

Darwin Harbour bathymetry described as part of the Ichthys project investigations, showed the main channel of the Port of Darwin at around 15-25 m deep, with maximum depths of 36 m (INPEX Browse Ltd, 2010a). Within East Arm towards Bladin Point, bathymetry was found to have been modified by dredging for the development of East Arm Wharf, with water depths of more than 10 m below Lowest Astronomical Tide (LAT) (INPEX Browse Ltd, 2010a).

7.1.3.3 Water quality

Collection of water quality data from Darwin Harbour has been undertaken as part of various industry and government investigations including:

+ The NT Government Darwin Harbour integrated marine monitoring and research program (IMMRP); this is a long-term program which commenced in November 2014 and has included a number of water quality investigations in the harbour including; the 'Developing an integrated long-term monitoring program for Darwin Harbour' project comprising a number of sub-projects:
  - Water Quality Pilot Project WP1: Neap Tide Trial (Makarynska, 2019a), which aimed to determine the optimal tide-based sampling conditions for long-term water quality monitoring; and
  - Water Quality Pilot Project WP2 (Makarynska, 2019b), which examined temporal variability of the harbour surface water quality.
+ NT DEPWS Water Quality Monitoring Program (WQMP) - Water quality data from multiple sites within Darwin Harbour is collected twice annually during neap tides in the early (May) and late (October) dry season by the Aquatic Group of the DEPWS; this data is reported annually via Darwin Harbour Region Report Cards.
+ The monitoring data are collated with data from other organisations and provides broad scale monitoring of water quality. The DENR WQMP currently undertakes two sampling campaigns per annum. Surface water quality (pH, dissolved oxygen, salinity, temperature and turbidity) is measured at one-second intervals along continuous transects including at sites within the harbour, using a flow-cell method that continuously pumps water through a water quality instrument. Water samples are also collected and analysed for nutrients and chlorophyll-a.
+ INPEX Ichthys NEMP water quality monitoring within Darwin Harbour; including 12-month time series baseline data collection and dredge (and spoil disposal) monitoring. Water quality parameters included turbidity and temperature and include extensive time-series monitoring data sets. Monitoring included real-time turbidity monitoring adjacent to coral and seagrass communities as well as reference sites pre-dredging (2010 to 2011) and during dredging and post-dredging from 2012 to 2015. The program also reported suspended solid concentrations in surface waters throughout Darwin Harbour and the Beagle Gulf derived from daily MODIS satellite images (Buckee et al, 2014).

Water quality investigations report water quality in Darwin Harbour as highly variable both spatially and temporally. There is a natural spatial gradient in some water quality parameters (i.e. turbidity) that extends from the upper estuaries towards the outer harbour. Generally, water in the upper estuaries is more turbid than that of the outer harbour and salinity in the upper estuaries is lower during the wet season and higher during the dry season. Sediment plumes can extend over wide areas of the harbour and turbidity values range from five Nephelometric Turbidity Units (NTU) in the dry season to in excess of 400NTU during the wet season (Nicholas et al, 2019).

Upper estuaries waters are generally higher in nutrients and chlorophyll a, indicating higher productivity (various in Makarynska 2019a). The temporal variation in water quality operates at seasonal and tidal scales. Seasonal influences on water quality are driven by the climatic differences between the wet and dry seasons. During the dry season, dry south-easterly airstreams pass over the top end of the NT resulting in very little or virtually no rain. In the wet season, monsoonal north-westerly winds produce waves that stir up sediments and impact on water quality, whilst runoff from the catchment introduces freshwater and dissolved and particulate material to the harbour that affects salinity and turbidity (Buckee et al, 2014, Makarynska 2019).

Tidal influences, including tidal range and stage of tide have a significant effect on water quality in the harbour with turbidity and suspended particulate material being most affected by tides, whilst it seems chlorophyll a is least affected (Buckee et al, 2014, Makarynska 2019b). Tidal impacts depend on location and are mediated, for example, by the proximity to mangroves, which usually act as sinks for suspended particulate material (INPEX Browse Ltd, 2010a).

Water temperature variations in Darwin Harbour are driven by seasonal variations in ambient air temperature that drive heat exchange between the water surface and atmosphere. Temperatures are also influenced by mixing of differing water masses, for example waters from the Beagle Gulf and freshwater inflow from creeks and rivers. During the Ichthys NEMP, wet season water temperatures were generally between 30 °C and 32 °C and dry season temperatures varied between 24 °C and 26 °C (Cardno, as reported in INPEX Browse, Ltd, 2018). While high water temperatures (>32 °C) are known to occasionally occur during the wet season, these are often short-lived due to significant rainfall events or the influx of cooler water into the harbour from the Beagle Gulf.

A number of findings indicate that although the movement of water is large, water renewal may not occur with every spring tide, depending on location within the harbour. These lines of evidence come from hydrodynamic modelling (Williams et al, 2006), the observation of hypersaline waters in the upper reaches of East Arm during the dry season (Padovan, 1997), and retention of herbicides at very low concentrations in the upper reaches of Middle Arm (DENR, unpublished data as reported in Makarynska 2019b).

Light levels at the seabed in the harbour were investigated as part of the Ichthys NEMP and were observed to typically be highest when the low water level (i.e. minimum depth) occurs around solar noon (Cardno in INPEX Browse, Ltd, 2018). In consideration of water depth alone, potential light levels at the seabed are generally highest from October to February, when the sun is highest (and most intense) and the lower of the two daily low tides during springs occur around solar noon. However, during this period in Darwin Harbour wet season cloud cover is often extensive, which reduces the amount of surface light and hence light reaching the seabed. Suspended sediments reflect and scatter light reducing the distance surface light penetrates into the water column. While tidal effects on the water depth tend to work to maximise light in the wet season, these effects are typically counteracted by elevated turbidity driven by tidal currents, increased winds and waves, and sediment-laden runoff from increased rainfall. Differences in light and turbidity levels were most pronounced at sites outside of Darwin Harbour (Cardno in INPEX Browse, Ltd, 2018). Low benthic light levels are known to occur at any time throughout the Darwin region, typically due to the coincidence of high tides and elevated turbidity. Extended periods of naturally low light levels and ‘blackout’ conditions (i.e. no light) are most prevalent during episodic events in the wet season; however, these occur variably.

Report cards for 2019, generated as part of DEPWS WQMP, for sites within Darwin Harbour graded the harbour’s water quality as good to excellent in 2019 (DEPWS, 2019) except for the Buffalo Creek estuary, which was found to be impacted by the wastewater discharge from the Leanyer-Sanderson sewage treatment plant, causing elevated nutrients and organic matter enrichment (DEPWS, 2019; Radke and Fortune, 2020).

7.1.3.4 Sediment quality

Sediment grain size analysis reported in Nicholas et al (2019) indicates the Darwin-Bynoe region is dominated by sand size sediment, with gravel present in Darwin Harbour (and on the western part of the outer Bynoe Harbour). Very fine sediment is present in patches on the shelf. The derived sediment textural information indicates that for the most part sediment here is mixed. Gravel textures tend to be located in deeper water, and on more rugose seabed, while the muddy textures tend to occur where the seabed within the tidal harbour is smooth. Overall, the sediment grain sizes, textures and sorting values indicate a moderately high energy setting. These determinations fit with the general coastal/estuarine setting and the tidal currents.

Unconsolidated sediments including muds and sand have been estimated to cover about 80 to 87% of the seafloor with the remainder being exposed rock (Smit et al, 2012).

A recent field survey sampled 53 sites along the Project pipeline (**Appendix D**) and identified three soft substrate types in Darwin Harbour (refer to **Figure 7-2**). The first was coarse shelly sand waves, less than 1 m with very sparse epibiota, and was only seen at three sites at the outer edges of Darwin Harbour (also in potential trenching locations).

The most common soft substrate habitat type within Darwin Harbour consisted of silty, shelly sand, with very sparse to no biota. The biota found in this habitat included hydroids, occasional soft corals (gorgonians, *Pennatulacea, Junceella* and *Alcyoniidae*), Bryozoa (lace coral), sea urchins and sea stars.

Only one site sampled had a habitat of silty shelly sand, with very sparse biota (soft corals) with scattered bommies. The bommies supported hydroids, soft corals (gorgonians), anemone colonies and encrusting sponges.

This is consistent with those sediment types identified by INPEX Browse, Ltd (2010a):

+ Terrigenous gravels present primarily in the main channel;
+ Calcareous sands with >50% biogenic carbonate occurring among or close to the small coral communities around Lee Point, Channel Islands and East Point;
+ Carbonate sediments, primarily derived from molluscan shell fragments, present in spits and shoals close to the harbour mouth;
+ Terrigenous sands on spits and beaches, with 10–50% carbonate, largely derived from mollusc shells. This type of sediment primarily comprises quartz and clay; and
+ Mud and fine sand on broad, gently inclined intertidal mudflats that occur in areas with low current and tidal velocities.

Soft surfaces with varying amounts of sand and gravel occur in the main channels around reefs, on beaches, and on spits and shoals near the harbour mouth; and there is a gradual transition between muddy, sandy and coarser sediments, as well as sediment movement caused by large tidal influences. Coarser material appears to be located in central channels of tributaries and the main body of the harbour rather than landward margins.

Sediment quality assessments within the harbour, undertaken as part of the Ichthys project reported on a range of potential contaminants. Sediment quality data within the Ichthys East Arm dredging footprint, as well as the Ichthys pipeline footprint are summarised below:

+ Metals: Concentrations recorded were generally less than relevant screening criteria at that time (National Ocean Disposal Guidelines for Dredged Material screening levels). Arsenic is naturally elevated in Darwin Harbour sediments. Bioavailability testing indicated only a small fraction of soluble Arsenic is bioavailable and hence, unlikely to be toxic in the marine environment. Arsenic concentrations in subsurface sediments were less than screening criteria. Metal concentrations were found to be similar throughout three sampling areas in East Arm, along the pipeline, shore crossing surface and sub-surface sampling sites.

+ Organics: Tributyltin (TBT), Total Petroleum Hydrocarbons (TPH), Benzene, Toluene, Ethylbenzene and Xylene compounds (BTEX), Polynuclear Aromatic Hydrocarbons (PAH), Polychlorinated Biphenyls (PCB), Organochlorine Pesticides (OCP) were generally below laboratory detection limits.
+ Nutrients: Generally, concentrations of Nitrite and Nitrate as Nitrogen were low (average concentration 0.28 mg/kg), therefore forming an insignificant proportion of the total nitrogen pool. Mean Total Kjeldahl Nitrogen (TKN) was found to be 581 mg/kg. In the absence of guideline values within Australia, data from the USEPA indicated that elevated TKN was approximately 3,000 mg/kg (although the study area is different to Darwin). Mean total phosphorus (TP), concentrations were comparable to previous studies in the area.
+ Sediment testing indicated potential acid generation along the Ichthys pipeline if sediments are exposed.

Preliminary sediment quality data within Darwin Harbour was collected to provide further understanding of baseline sediment quality within the Project Area (RPS 2021). Sediment quality investigations included sampling within the sand wave spoil disposal ground (18 grab samples) and from the pre-lay trenching area (33 grab samples). Geotechnical investigations will also acquire sediment data via core sampling (approximately 17 core samples planned).

The results of the survey are included as **Appendix D**.

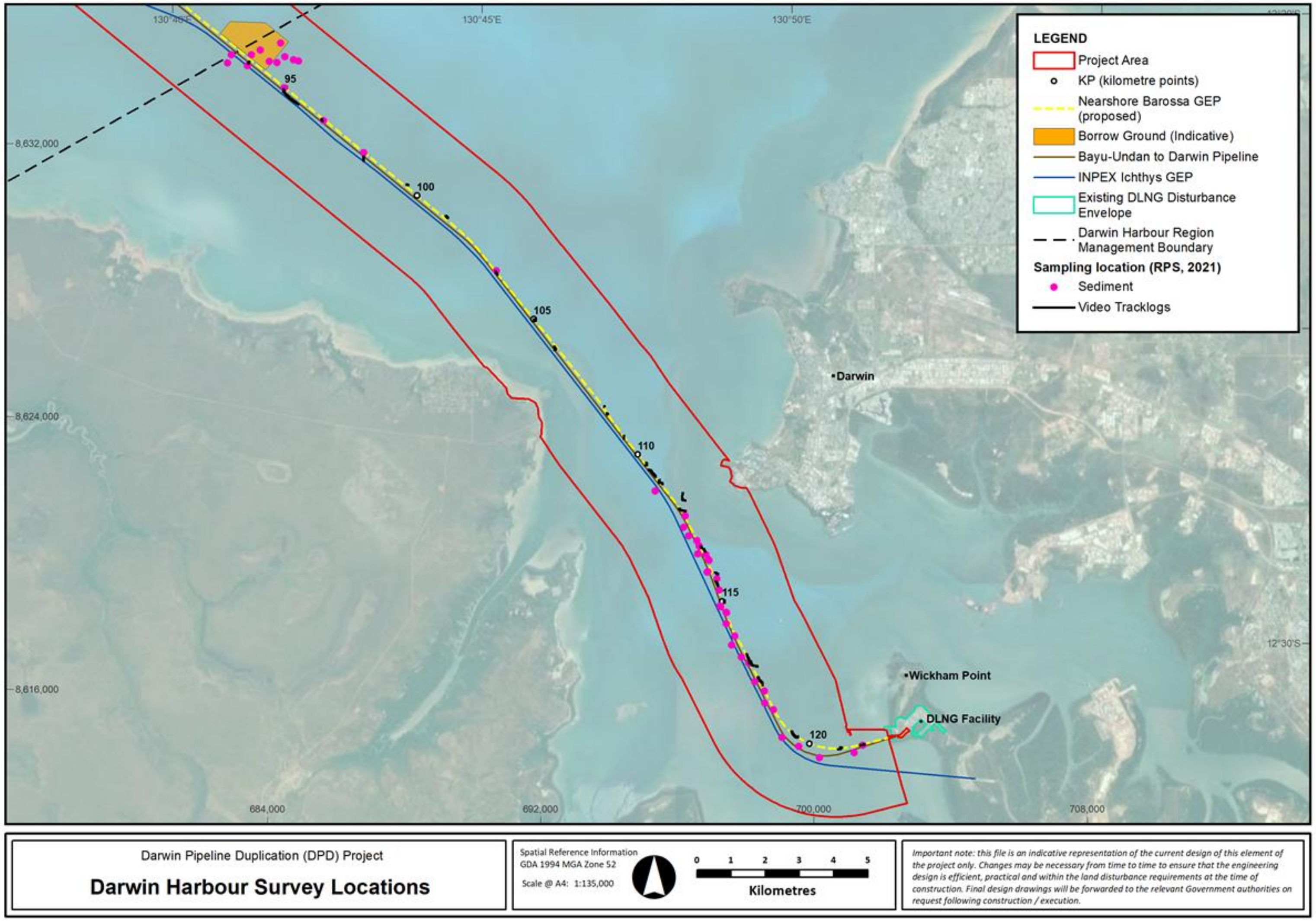


Figure 7-2 Darwin Harbour marine environmental survey locations (RPS, 2021)

7.1.3.5 Baseline noise

Underwater noise monitoring in Darwin Harbour was conducted in 2009 to characterise the baseline acoustic environment as part of the Ichthys EIS and in subsequent years during monitoring of the Ichthys project construction.

Underwater noise in Darwin Harbour is influenced by existing shipping traffic, biological sources and weather. Prominent sources of noise include thunderstorms, lightning strikes and heavy wet-season rains, which generate noise at considerable intensities. While these natural noise sources occur only seasonally, vessel traffic in Darwin Harbour is present year-round with the Port of Darwin recording 2,154 vessel visits in 2018-19 (refer **Section 7.4.1**).

The results of noise monitoring conducted for the Ichthys EIS in Darwin Harbour are included:

+ Within the 0–50 Hz spectrum, the peak noise recorded was concentrated below 20 Hz. This low frequency spectrum is generally below the hearing range of most of the marine megafauna in Darwin Harbour. While baleen whales can hear at this low frequency, they visit the harbour very rarely. The study noted that sound-pressure levels in the Elizabeth River were distinctly lower than those in the broader parts of East Arm (around 100 dB re 1 µPa2/Hz, compared to around 150–170 Decibel (dB) re 1 µPa2/Hz), as the shallower water, more complex landform and soft-bottom substrate in the Elizabeth River all reduce noise propagation (INPEX Browse, Ltd, 2010a).
+ The mid-frequency spectrum between 50 and 2000 Hz shows very wide variations in the ambient noise levels recorded, which is a result of the acoustic complexities of the area. The sound-pressure recordings in East Arm within the mid-frequency spectrum generally ranged between 50 and 90 dB re 1 µPa2/Hz, but reached 120 dB re 1 µPa2/Hz in one of the recordings (INPEX Browse, Ltd, 2010a).
+ The high-frequency >2000-Hz spectrum of ambient noise in the harbour is generally at sound-pressure levels of 30–70 dB re 1 µPa2/Hz. This spectrum is dominated by the sound of snapping shrimp, which typically has a peak frequency of 5–7 kHz. Targeted recordings of three tugboats in the harbour were typical of small diesel-powered vessels. The recordings measured point-source noise from propellers in the range of 30–100 Hz, from the diesel engines in the range of 100–1000 Hz, and broadband propeller cavitation noise mainly up to 15 kHz, but extending as high as 96 kHz (the maximum for the hydrophone) at very close range. Measurements of tugboats working alongside an LNG tanker from a distance of 230 m recorded broadband noise at received levels of 205 dB re 1µPa (INPEX Browse, Ltd, 2010a).

7.1.4 Shore crossing

The baseline description for the physical environment at the shore crossing, draws on the work carried out as part of the DLNG Life Extension NOI (ConocoPhillips, 2019a). Given the shore crossing is adjacent to the existing Bayu-Undan to Darwin pipeline and connects into the existing DLNG facility, the summary below is considered directly relevant.

Further details on the terrestrial environment, including flora, vegetation, fauna and acid sulphate soils, are provided in **Section 7.3**.

7.1.4.1 Geology, soils and geomorphology

The bedrock consists of meta-sediments that have metamorphosed and undergone one major deformation, producing steep dips and resulting in the pervasive north-north-east strike of the strata. The Burrell Creek Formation present at the shore crossing consists of a sequence of phyllite, siltstone, shale, sandstone and conglomerate (ConocoPhillips, 2019a).

Parts of the Koolpinyah surface are present on the Peninsula, and take the form of laterite deposits on bench areas of lower slopes or the flanks of the ridges and as extensive platforms near sea level. There is a prominent ferricrete pavement near sea level that extends seawards out to the low tide level. It forms a capping on the shallow near shore reefs (ConocoPhillips, 2019a).

Offshore subsurface stratigraphy is represented by 5 m to 9.5 m of sediment in the DLNG facility jetty head area, underlain by phyllite and meta-siltstone of the Burrell Creek formation (ConocoPhillips, 2019a).

7.1.4.2 Acid sulphate soils

Acid sulphate soils (ASS) are formed by natural processes and predominantly occur in low-lying coastal areas. Coastal estuarine and mangrove environments develop ASS due to the waterlogged nature, saltwater influences and anaerobic soils associated with such landforms.

ASS mapping of the Darwin Region indicates that material present in the Project Area contains a high potential for occurrence of acid sulphate soils (PASS). The bottom sediments associated with the offshore area of the site are also mapped as PASS. URS conducted an ASS investigation for the DLNG project in 2002 with findings concluding the presence of ASS material within the mangrove muds that underlay tidal flats and mangrove communities along the shoreline of Wickham Point (Phillips Petroleum Company, 2002).

7.1.4.3 Surface water and groundwater

There are no permanent freshwater habitats at the shore crossing or the adjacent mainland peninsula. However, there are several small creek lines that flow from upland areas to the harbour during the wet season (ConocoPhillips, 2019a).

The NR maps shows several current groundwater bores within the DLNG facility. Biannual monitoring of groundwater for the DLNG facility has been undertaken since 2015 of both onsite groundwater and an offsite reference bore. Groundwater levels fluctuate between approximately 0.5 m and 4.0 m relating to the seasonal rainfall cycles, with a higher groundwater water table in the wet season compared to the dry season. The groundwater pH is mostly acidic with a range of 3.9 to 6.7, conductivity range recorded is from 109 to 82,000 microSiemens per centimetre (µs/cm), the variation is dependant again on seasons (rainwater is a freshwater input) and on bore locality with respect to saline Darwin Harbour. Generally, the site groundwater has a lower conductivity given the irrigation water freshwater input is consistent throughout the year (ConocoPhillips, 2019a). In regard to heavy metals, the monitoring shows levels are naturally elevated across the site bores and the reference bore, reflective of the geology of the area. All metals (except arsenic, iron and manganese), on average, are higher at the offsite reference bore compared to onsite groundwater likely indicating the irrigation water causes dilution of natural concentrations (ConocoPhillips, 2019a). Total phosphorus concentrations range from below detection limit (0.05 mg/L) to 1.76 mg/L and total nitrogen concentrations range from below detection limit (0.001 mg/L) to 21.3 mg/L. Comparative to the reference bore, some onsite bores have recorded elevated nutrient concentrations.

Given the intense monsoonal rainfall that causes high volumes and velocities of surface water runoff, and the structureless and sodic nature of the soils in the Darwin region, surface water runoff can also carry sediments from erosion.

7.2 Marine and intertidal environment

7.2.1 Benthic habitats and communities

7.2.1.1 Offshore NT waters

Benthic habitats were characterised along the Ichthys pipeline as part of the Ichthys EIS by drop camera (INPEX Browse, Ltd, 2010a). The description for Ichthys pipeline KP 706 to KP 862.77 (the route as it approaches the Darwin Harbour port limits from offshore) is of relevance given its relative proximity to the offshore Project Area. INPEX Browse, Ltd (2010a) describe this area as being largely characterised by featureless clay / silt sands with areas of megaripples and sand waves.

Fauna recorded from remove video sampling within this area comprised sessile benthos including hydroids, feather star (Crinoidea) and sea pens (Pteroeidae) in water depths of 12 m.

Habitat mapping of the Oceanic Shoals Marine Park has previously been developed by AIMS based on spatial predictive modelling and using data collected during the Barossa baseline studies program, AIMS (Heyward et al, 2017) extended the benthic habitat model to develop a regional habitat map that encompassed the entire Barossa GEP, including the additional Barossa GEP segment in Commonwealth waters. This study classified benthic habitats along the Barossa GEP route as largely bare sediments, with relatively small areas of burrowers / crinoids and filter feeders. All of these habitat types are well represented throughout the region, and along the Barossa GEP, these habitats are not unique or regionally significant (Heyward et al, 2017; Radford et al, 2019). Given the continuous substrate and seabed features from this area into Darwin Harbour, the same benthic habitat composition is expected along the offshore section of the Project pipeline.

RPS (2021) conducted baseline investigations using drop/towed video at 30 sites to describe the seabed of the offshore Project pipeline. The results are included in full in **Appendix D**, and summarised below.

The benthic habitats along the offshore Project pipeline verified the expectations from the AIMS habitat modelling and were silty shelly sand, with, burrows and polychaete worm tubes. Biota commonly associated with this habitat type were very sparse to sparse, and included hydroids, soft corals (gorgonians, *Junceella* and *Alcyoniidae*), and sea stars. This soft sediment habitat was also present at the end of the Project pipeline. Within three of these silty shelly sand sites, there were sections of sand waves, roughly one metre high, with silty sand in the troughs and coarse shelly sand at the peaks. This substrate was associated with very sparse epibiota.

The spoil disposal ground sites all consisted of the same soft substrate habitat. This habitat is defined by silty/clay sediment with medium density biota. Biota commonly seen at this habitat were soft corals (gorgonians, *Junceella, Alcyoniidae*), branching and encrusting sponges, Bryozoa (lace coral), invertebrate burrows, polychaete tubes, brown algae and occasional motile crinoids.

7.2.1.2 Darwin Harbour

Geoscience Australia, AIMS and the Northern Territory Government Department of Environment and Natural Resources (DENR) undertook a collaborative seabed mapping survey in the Darwin-Bynoe Harbour region between 2015 and 2018 (Nicholas et al., 2019). AIMS used the data to map the distributions of benthic habitats in the Darwin (and Bynoe) Harbour region (refer to **Figure 7-3**). The study included 150 towed video survey transects within Darwin Harbour (including a transect within and proximate to the Project pipeline) to provide ground-truth information on the occurrence of benthic biota for model generation and error assessment (Galaiduk et al, 2019).

The work by Galaiduk et al, 2019 concluded that most of the benthos of Darwin (and Bynoe Harbour) was predicted to be highly suitable for a variety of filter-feeding biota such as sponges and octocorals. Shallower areas with hard substrate were more suitable for the hard corals and macroalgae. Hard corals and macroalgae were also predicted in isolated pockets across outer areas of Darwin (and Bynoe) Harbour especially near Middle and Fish Reefs. In contrast, seagrass was mainly predicted to be associated with the shallow areas outside of the main channels. Water depth appeared to be the main driver of distribution of the modelled benthic classes. The shallow areas (< 10 m) were typically characterised by the presence of autotrophic communities such as macroalgae, seagrass and hard corals. The shallows were further divided based on the structural complexity with more complex areas were typically dominated by the hard corals and macroalgae whereas the seagrass areas were typically characterised by relatively lower complexity. The deeper slopes (> 10 m) with varying degrees of associated complexity were found to be highly suitable for the heterotrophic filter feeding communities. In contrast, deep, low complexity flat areas had typically no associated epibenthic biota.

Mapping of marine habitats in Darwin Harbour was also undertaken to support the INPEX Ichthys LNG project which shows that habitats in the vicinity of the DLNG facility are characterised by intertidal flats and intertidal rock platform habitats (INPEX Browse, Ltd, 2010a). As part of the Ichthys EIS Supplement, a comprehensive baseline marine habitat survey was completed (as described in INPEX Browse, Ltd, 2010a).

Darwin Harbour has a complex assemblage of marine habitats and there are large differences in the extent, diversity and significance of the associated biological communities. Rocky intertidal areas are found where headlands protrude into the harbour. Extensive mangrove communities dominate in the bays and other protected areas throughout the intertidal zone. Seaward of the mangroves, extensive flats occur in the lower intertidal zone. Many of these flats are mud, but some areas are basement rock that may have thin veneers of sand or mud (INPEX Browse, Ltd, 2010a; ConocoPhillips, 2019a). Seaward of the mangroves, a range of intertidal and subtidal habitats occur supporting seagrass, coral and macroalgae communities.

A benthic habitat assessment of the Project pipeline within Darwin Harbour was undertaken to characterise benthic habitats within this area. These sites were guided by geophysical assessments of the route.

The key results of the benthic habitat assessment undertaken by RPS (2021) are included in full as **Appendix D**, and summarised below.

The Project pipeline within Darwin Harbour consisted of soft and hard substrate habitats. There were three soft substrate habitats identified in the survey, as described below.

Sand waves, less than one metre, made up of coarse shelly sand with very sparse epibiota were found at three sites, all of which were in the potential sand wave trenching location at the outer edges of Darwin Harbour. While epibiota in this habitat was very sparse, grab samples from one of the sites in this area found a very high density of hermit crabs, with over 100 crabs in each grab.

The most common soft substrate habitat type within Darwin Harbour consisted of silty, shelly sand, with very sparse to no biota. The biota found in this habitat included hydroids, occasional soft corals (gorgonians, *Pennatulacea, Junceella* and *Alcyoniidae*), Bryozoa (lace coral), sea urchins and sea stars.

Only one site (near KP 122), had a habitat of silty shelly sand, with very sparse biota with scattered coral bombora. The coral bombora supported hydroids, soft corals (gorgonians), anemones, soft corals and encrusting sponges.

Most of the hard substrates were along the Project pipeline offshore from Fanny Bay. Most of these sites were hard bottom (reef) with a shelly sediment veneer and sparse to medium biota (soft corals and Bryozoa). However, two sites were identified as low-profile reef, with medium to high density biota. The biota found at this habitat type included hydroids, soft corals (gorgonians, *Junceella*), brown algae, Bryozoa (lace coral), ascidians, and encrusting, digitate and globular sponges.

7.2.2 Wetlands

Darwin Harbour is a working harbour that is listed as a wetland of national significance in the Directory of Important Wetlands in Australia and has international significance rating due to there being 15 threatened species reported as being found at the harbour. Conservation initiatives, such as a Regional Plan of Management and ecosystem monitoring, have been developed and established (Harrison et al, 2009).

The Port Darwin wetlands (NT029 Port Darwin) are listed as a Nationally Important Wetland under the Directory of Important Wetlands in Australia (DoEE, 1993). The site includes the entire embayment (where less than 6 m deep at low tide) of Port Darwin and encompasses 48,000 hectares. The wetlands are located within the inner shores of Darwin Harbour and the Project area overlaps with a small section of the wetlands, as shown in **Figure 7-4**. The wetlands are well represented throughout the harbour and the small section overlapped by the Project Area is of low ecological value.

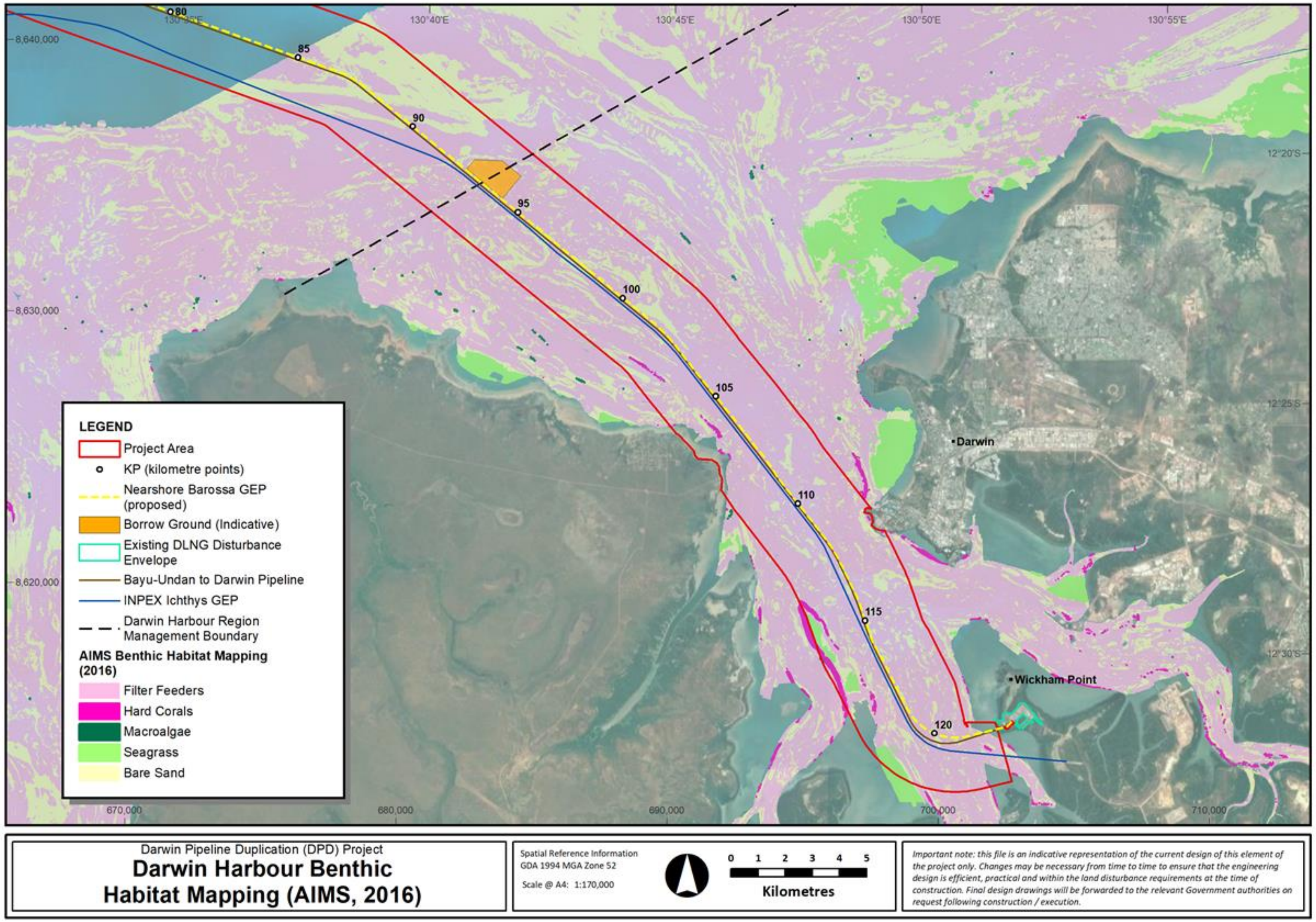


Figure 7-3 Darwin Harbour benthic habitat mapping (AIMS, 2016)

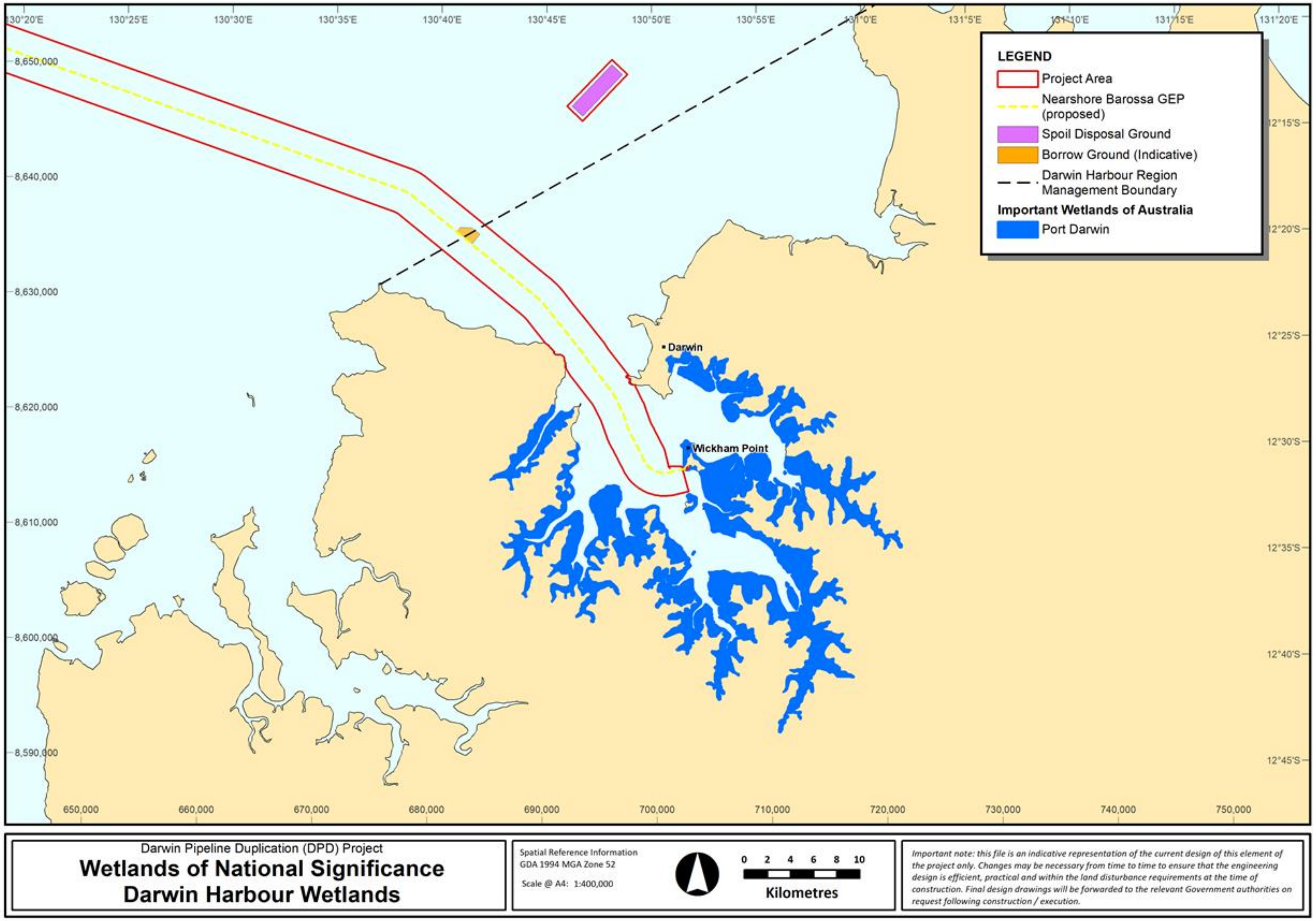


Figure 7-4 Wetland of National Significance – Darwin Harbour wetlands

7.2.3 Mangroves

7.2.3.1 Regional context

Mangroves abutt the already cleared shore crossing location where the Project pipeline is to make landfall. Mangrove community mapping for Darwin Harbour (Brocklehurst and Eameades, 1996) shows that the Project Area is likely to consist of three broad mangrove communities:

+ Mangrove Closed Forests – Ceriops australis/Avicennia marina low closed forest (high tidal flat);
+ Mangrove Open Forests – Mixed species low closed forest/open forest (tidal flat margin); and
+ Mangrove Woodlands/Open Woodlands – Sonneratia alba woodland in the seaward zone (low tidal flat).

The intertidal mudflats of the greater Darwin Harbour area are covered by tracts of mangrove up to 27,350 ha, about 44% of the bioregion's community and approximately 5% of the total mangrove areas of the Northern Territory. The inner harbour mangroves account for 80% of this total with 400 ha being cleared up until 2002. The species richness of the community is well known having 36 of the 50 mangrove species worldwide. The most common mangroves species in Darwin Harbour are Rhizophora stylosa, Ceriops tagal, Sonneratia alba, Bruguiera exaristata, Avicennia marina and Camptostemon schultzii. Distinct mangrove assemblages have been classified into 11 groups (INPEX Browse, Ltd, 2010a). Mangroves are a valuable part of the ecosystems as nursery and spawning ground for fish, crustaceans and prawn species. These assemblages hold recreation value and produce large amounts of organic matter and nutrients (INPEX Browse, Ltd, 2010a).

Key adaptations to the intertidal environment are specialised aerial roots systems to facilitate respiration in anerobic waterlogged soils. Cable roots and pneumatophores occur in Sonneratia and Avicennia genera as opposed to buttress trunks in Rhizophora, Camptostemon and Ceriops.

Figure 7-5 shows the zonation of mangrove habitats, specific to Darwin Harbour.

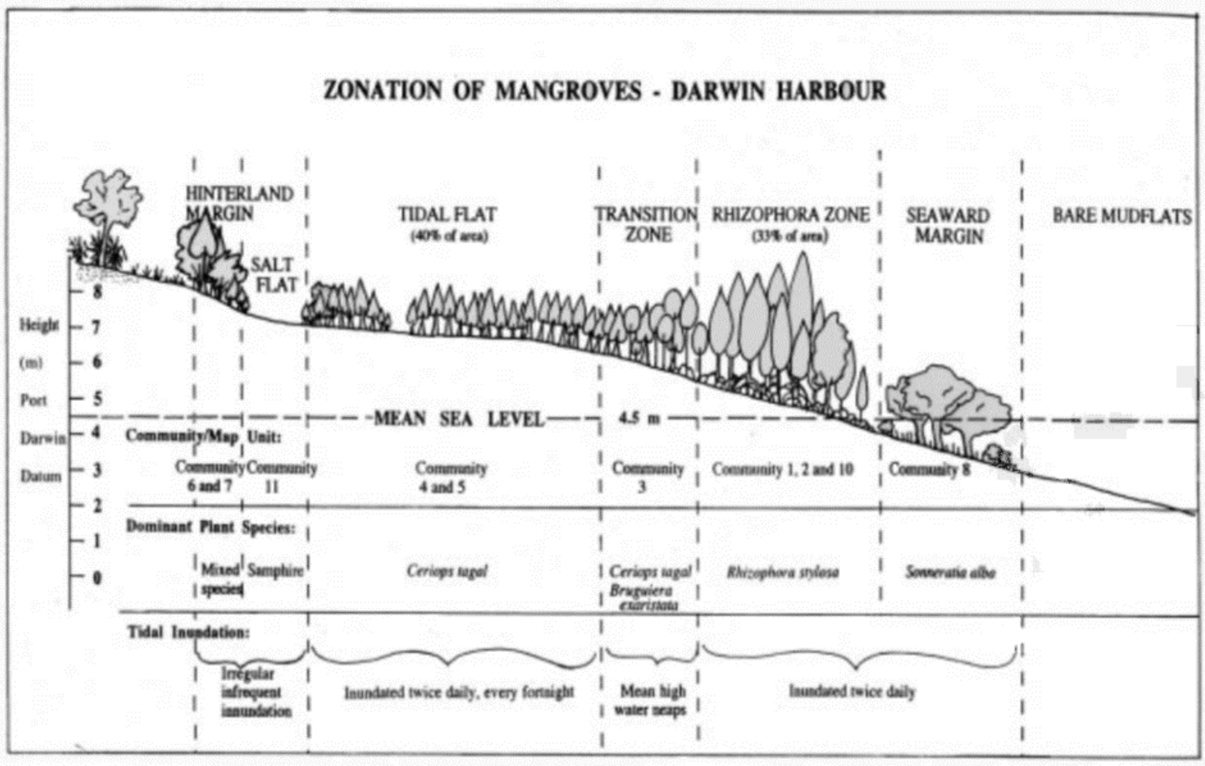


Figure 7-5 Zonation of mangroves in Darwin Harbour (Brocklehurst, 1996)

7.2.3.2 Mangrove monitoring program

The mangrove community surrounding the DLNG facility comprises predominantly of *Rhizophora* and *Sonneratia* species, and to a lesser extent *Aegialitis, Avicennia, Osbornia* and *Aegiceras*.

Monitoring of mangrove health was most recently conducted in August 2021, within 23 surveillance sites located around the perimeter of the DLNG facility. Monitoring of mangroves in the vicinity of the DLNG facility has been ongoing since commencement of construction in 2003, conducted initially on a quarterly basis and since 2007 on an annual basis. This represents one of the longest continuous mangrove monitoring programs in the Darwin Harbour and perhaps northern Australia. The program incorporates mangrove community health surveillance monitoring as well as chemical assessment of sediments and mudwhelks. The monitoring program includes representation of all assemblage types as well as the existing shore crossing areas and several monitoring locations are adjacent to the Project pipeline.

Data collected indicates that mangroves adjacent to the DLNG facility are in a healthy condition with no significant deterioration or stress related to the operation of the DLNG facility. The data also shows that the key parameters of canopy density, tree condition, sedimentation/erosion (sediment heights) and groundwater conditions have remained largely unchanged during the operations phase (CDM Smith, 2021) although some impacts have occurred due to Cyclone Marcus in 2018. There was no evidence that substantial sedimentation or erosion has occurred that has the potential to affect mangrove health. Assessment of groundwater salinity within the mangrove monitoring sites over the last five years indicates there has been minimal change over time and there was no evidence of increasing salinities that may impact mangrove health. Similarly, there have been no evidence of contamination in mangrove biota (mudwhelks) from the DLNG operations.

7.2.3.3 Mangrove condition and health at shore crossing

During construction of the DLNG facility, a small corridor of mangroves approximately 60 m long and 50 m wide was cleared at the south-western tip of the Wickham Point peninsula to facilitate entry of the Bayu-Undan to Darwin pipeline (**Figure 7-6**). The zonation of mangrove forests surrounding the pipeline corridor is visible in aerial photographs and comprises the seaward mangrove edge assemblage dominated by Sonneratia alba trees, followed by the Rhizophora stylosa forest zone situated directly to landward. These two dominant species typically occur at specific tidal elevations, and their distribution is largely determined by hydroperiod, or the frequency and duration of tidal inundation.

Gradual revegetation of the cleared pipeline corridor via natural seedling recruitment has occurred since the construction phase. The shoreline crossing site is located on an exposed western-facing shore, supporting a relatively narrow mangrove forest on gravelly to rocky substrates to landward that intergrade with deep marine muds to seaward.

Figure 7-6 Aerial photographs of the pipeline shore crossing shortly after construction in 2006 (L) a decade later in 2016 (centre) and in 2020 (R).

Analysis of species distribution demonstrates the re-establishment of the natural pattern of shoreline zonation in the cleared corridor. Species characteristic of adjacent undisturbed mangrove assemblages have colonised the site. *Sonneratia alba* is dominant on the lower shore zone intergrading with *Rhizophora stylosa* higher in the intertidal zone. As recorded in the 2021 survey, recruitment is occurring over time mostly by common mangrove species typical of the low intertidal zone such as *Aegialitis annulata, Sonneratia alba*, *Rhizophora stylosa, Avicennia* marina and *Aegiceras corniculatum.*

Although substantial sections of the shore crossing remains sparsely vegetated, particularly adjacent to the rock wall that houses the pipeline (**Figure 7-7** and **Figure 7-8**), the absence of mangrove regeneration in this area may be associated with increased site elevation and the gravelly to rocky substrate, deeming it less favourable for mangrove establishment. A vegetation assessment was undertaken in November 2021 (CDM Smith, 2021) which confirmed only one species of mangrove in proximity to the Project pipeline; *Sonneratia alba*, of which there were only a handful of individuals (i.e. less than 5 within 20 m either side). This species of mangrove (*S. alba*) is a common taxon that is well represented and characterised as part of the mangrove monitoring programme at DLNG.

Figure 7-7 The shore crossing in August 2003 (left) and regrowth at the same location in August 2021 (right)

Figure 7-8 Photo-monitoring location (Site PSC1) photographed in 2020 (left) and in 2021 (right) at the permanent photo-point established at the shore crossing in August 2020

7.2.4 Fauna

7.2.4.1 Marine Reptiles

Six species of marine turtles are known to occur in Northern Territory waters and the EPBC Protected Matters search (refer to **Section 10**) identified all six as occurring or potentially occurring with the Project Area and surrounds (within 5 km). Two of these species, the Flatback (*Natator depressus*) and the Olive Ridley (*Lepidochelys olivacea*) are known to nest in parts of the NT that includes critical habitat and internesting biologically important areas (BIAs; spatially defined areas where aggregations of individuals of a species are known to display biologically important behaviour such as breeding, foraging, resting or migration). These areas extend into nearshore waters off the coastline of the NT and Tiwi Islands.

Peak internesting for Flatback turtles in the NT occurs between June-September and peak nesting for Olive Ridley turtles in the NT (i.e. Tiwi Islands) occurs between April-August (DoEE, 2017a). The Green (*Chelonia mydas*), Hawksbill (*Eretmochelys imbricata*) and Flatback turtles are the only species known to frequent Darwin Harbour regularly.

Flatback turtle BIA internesting and habitat critical to the survival of the species intersect the Project Area in both Commonwealth and NT waters (**Figure 7-9**). Olive Ridley turtle BIA and habitat critical to the survival of the species do not intersect directly with the Project Area, however an Olive Ridley turtle internesting area occurs around the south-eastern side of the Tiwi Islands, extending 20 km seaward and approximately 5 km north of the offshore NT waters, and a second area is located south-east of Darwin Harbour nearby to the Project Area (approximately 15 km to the east) (**Figure 7-10**).

Green turtles inhabit areas of coral and rocky reefs and inshore seagrass and algal beds. Adult Green turtles are herbivorous feeding primarily on seagrasses and algae, while juveniles are carnivorous (NRETAS, 2006a). The Hawksbill turtle prefers rocky and coral reef habitats where it feeds on a wide variety of plants and animals including sponges, gastropods, seagrass and algae. Flatback turtles inhabit shallow, soft bottomed seabeds and feed on soft corals and soft bodied animals such as jellyfish and sea cucumbers (DENR, 2006). Aerial turtle surveys undertaken for the INPEX NEMP estimated a population size of between 500 and 1,000 for the Darwin region (Buckee et al, 2014). Turtles were primarily observed in shallow waters (<10 m), with the highest densities recorded between East Point and Lee Point, and near Gunn Point (Cardno 2015 in INPEX Browse Ltd, 2018). Turtles were also sighted throughout Darwin Harbour, although at lower densities. It is likely that the majority of turtles observed in the harbour during these surveys were Green turtles, as they accounted for 74% of sightings during fine scale land-based observations (INPEX Browse Ltd, 2018).

No turtle nesting sites are known to occur in Darwin Harbour, with the closest nesting site in the Darwin region located at Casuarina Beach. Other turtle nesting sites include Bare Sand Island and Quail Island located near the mouth of Bynoe Harbour (~50 km from Darwin). Within the Darwin region most turtle nesting is associated with Flatback turtles, with only small numbers of other turtle species occasionally nesting in the area. A study undertaken by Chatto and Baker (2008) found that Flatback turtle nesting predominantly occurred between May and October; however, it was noted that at locations such as Casuarina Beach nesting was recorded in small numbers throughout the year.

The Saltwater crocodile (*Crocodylus porosus*) is a common resident of the Darwin region. In 2015 a total of 280 crocodiles were removed from Northern Territory waters with a majority of these being caught within Darwin Harbour (DENR, 2016). Saltwater crocodiles breed during the wet season between October and May. Preferred nesting habitat of the Saltwater crocodile includes elevated, isolated freshwater swamps that do not experience the influence of tidal movements (Saalfeld et al, 2016). Nesting within Darwin Harbour is limited (INPEX Browse Ltd, 2010a).

The North Marine Region (NMR) is an important area for seasnakes with nineteen species known to occur in the region. All are listed as marine species under the EPBC Act and in the context of the Project Area, nearby seabed features with variability in water depth and substrate composition such as the Carbonate bank and terrace system of the Van Diemen Rise are known to provide habitant for sea snake species (DSEWPaC, 2012a). Within Darwin Harbour, sea snakes are infrequently observed but are present as a diverse range of marine and mangrove-dwelling snakes including the most commonly encountered black-ringed sea snake (*Hydrelaps darwiniensis*) which tends to feed on mudflats during daylight hours (Guineas, McGrath & Love, 1993 in INPEX Browse Ltd, 2010a).

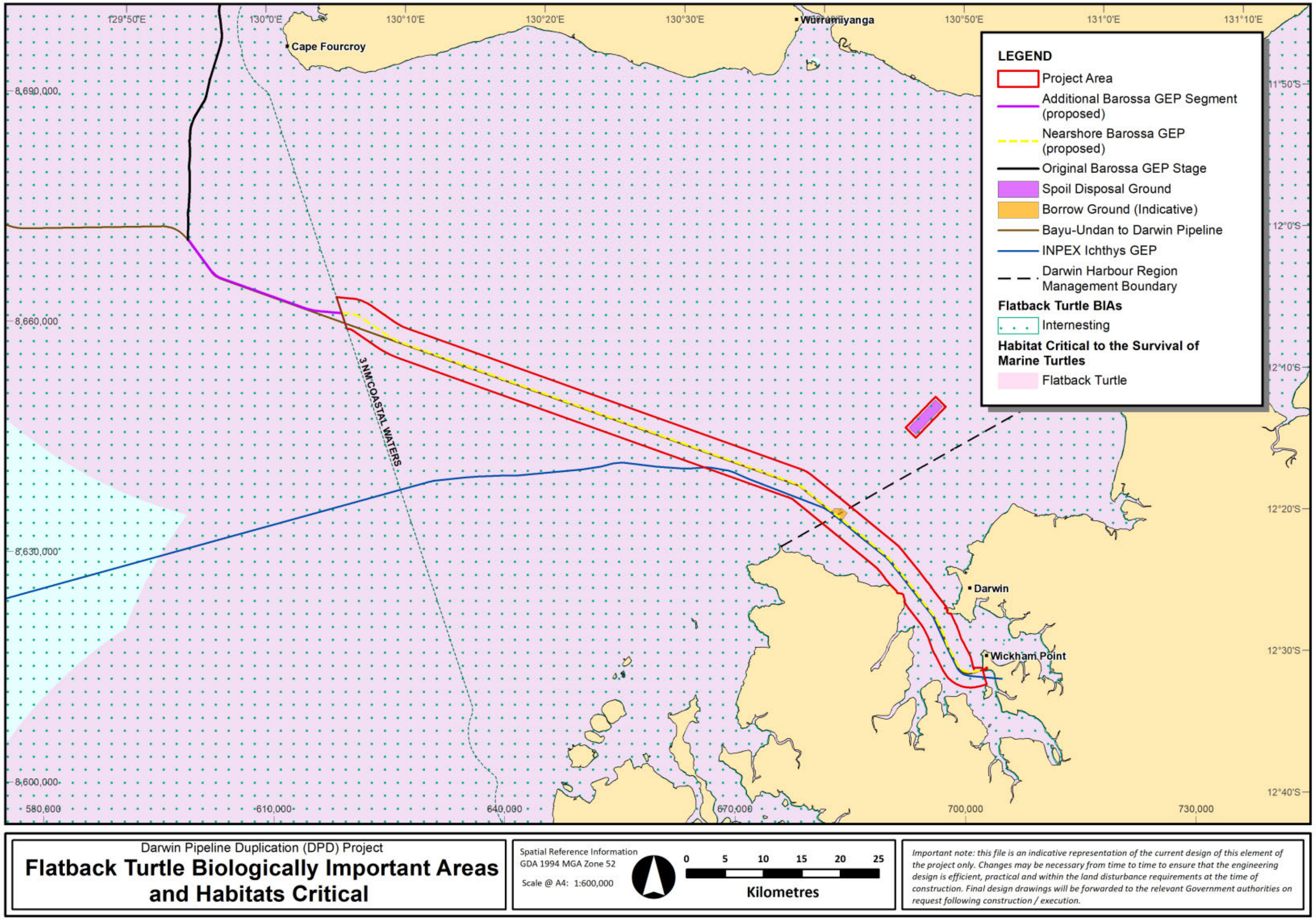


Figure 7-9 Flatback Turtle Biologically Important Areas and Habitats Critical

Santos

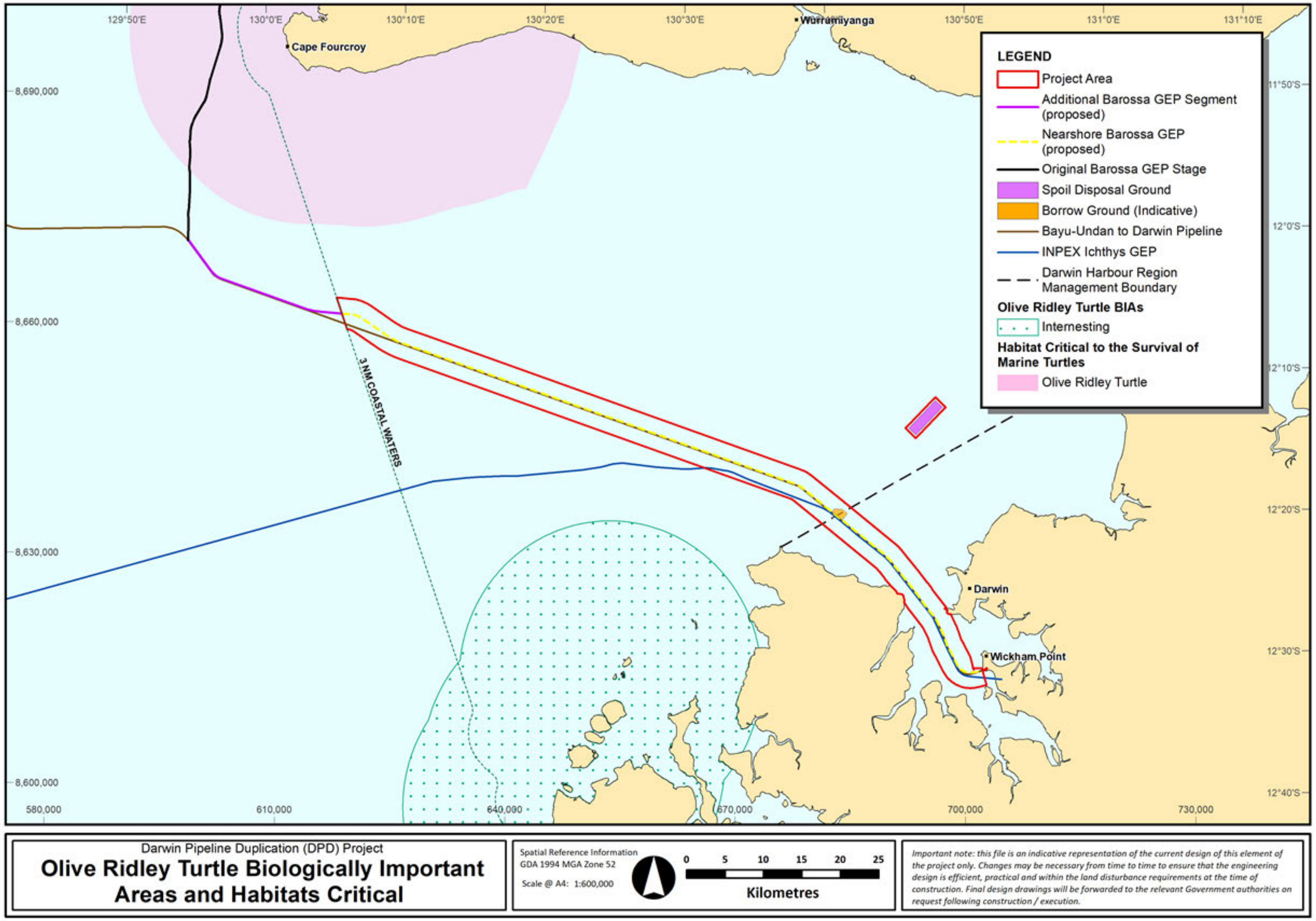


Figure 7-10 Olive Ridley Turtle Biologically Important Areas and Habitats Critical

7.2.4.2 Marine Mammals

Offshore NT waters

The Barossa GEP Installation EP (Santos, 2021) provides an overview of marine mammals potentially associated with the additional Barossa GEP segment in Commonwealth waters. This information is relevant in the context of the offshore areas of the Project and indicates that a number of whale species, including sei whales, fin whales, humpback whales, Bryde's whales, orcas and sperm whales may occur in offshore NT waters, although typically found further offshore within Commonwealth waters. Additionally, pygmy blue whales, Bryde's whale and Omura's whales were detected by ConocoPhillips during surveys of areas of the Barossa field and original Barossa GEP. It is therefore possible that these species may also transit the offshore NT waters area of the Project. However, there are no BIAs or other critical habitat for these whale species within the Project Area or the broader region.

Darwin Harbour

The most commonly recorded marine mammals in Darwin Harbour are dolphin species. The Australian snubfin (*Orcaella heinsohni*) (refer to **Figure 7-11**), the Indo-Pacific humpback (*Sousa chinensis*) (refer to **Figure 7-12**) and the Indo-Pacific spotted bottlenose (*Tursiops aduncus*) (refer to **Figure 7-13**) are known to have resident populations within Darwin Harbour (Shoal Bay and Bynoe Harbour). Overall, approximately 150 dolphins (all species combined) are thought to inhabit the Darwin region (Brooks & Pollock 2015 in INPEX Browse Ltd, 2018) with the Australian humpback dolphin being the most abundant, followed by Australian snubfin and then the bottlenose dolphin.

The DLNG Transition Work Program NOI provides a summary on the distribution of these dolphins drawing on information from the Marine Bioregional Plan for the NMR (DSEWPaC, 2012a) and a study on the feeding habits of Australian snubfin and Indo-Pacific humpback dolphins (Parr and Jedensjo, 2009). A coastal dolphin monitoring program for the Darwin region was also established in 2011 and finished in 2015 and a second program commenced in 2016 and finished in 2019 (Griffiths et al, 2020). Results from the two monitoring programs found the coastal dolphin populations within the Darwin region occur at low densities, exhibit substantial temporary emigration and have fluctuating population size (Brooks et al, 2017; Griffiths et al, 2020). The study by Griffiths (2020) provides insights into the areas such as social structure and habitat use, which may help to understand spatial and temporal patterns.

In addition to the previously described dolphin species, occasional pods of false killer whales (Pseudorca crassidens) are also known to frequent Darwin Harbour (INPEX Browse, Ltd, 2010a).

Dugongs (*Dugong Dugon*) are also known to occur in the Darwin region. Dugong monitoring using aerial surveys was undertaken as part of the Ichthys NEMP, and population estimates calculated from sightings observed during these surveys suggest that approximately 180 to 300 individuals inhabit the Darwin Region (Cardno, 2014 in INPEX Browse, Ltd, 2018). The Ichthys EIS Supplement estimated the spatial extent of foraging habitat for dugong in Darwin Harbour based on distribution of seabed communities suitable for foraging.

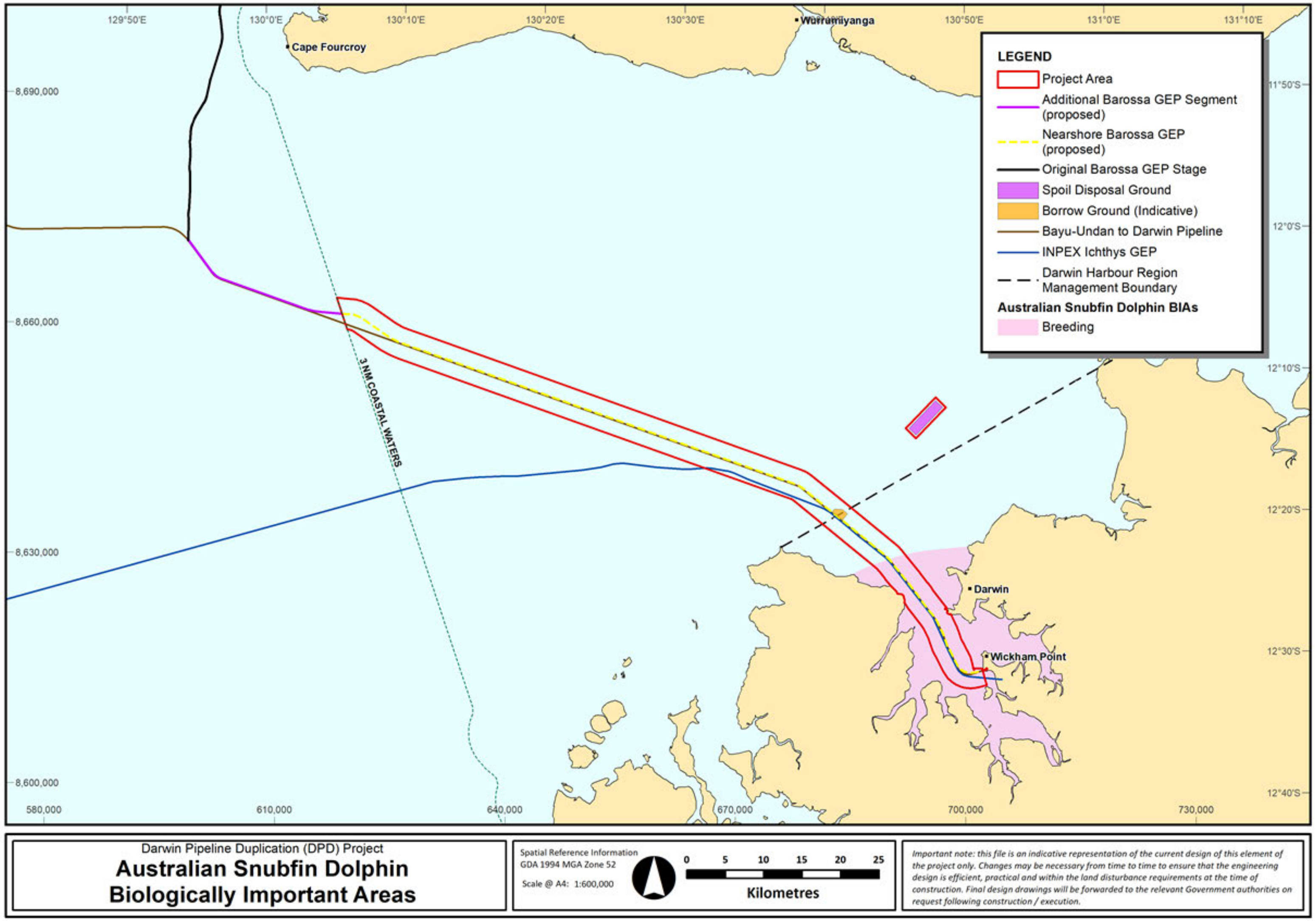


Figure 7-11 Biologically Important Areas for marine mammals – Australian Snubfin Dolphin

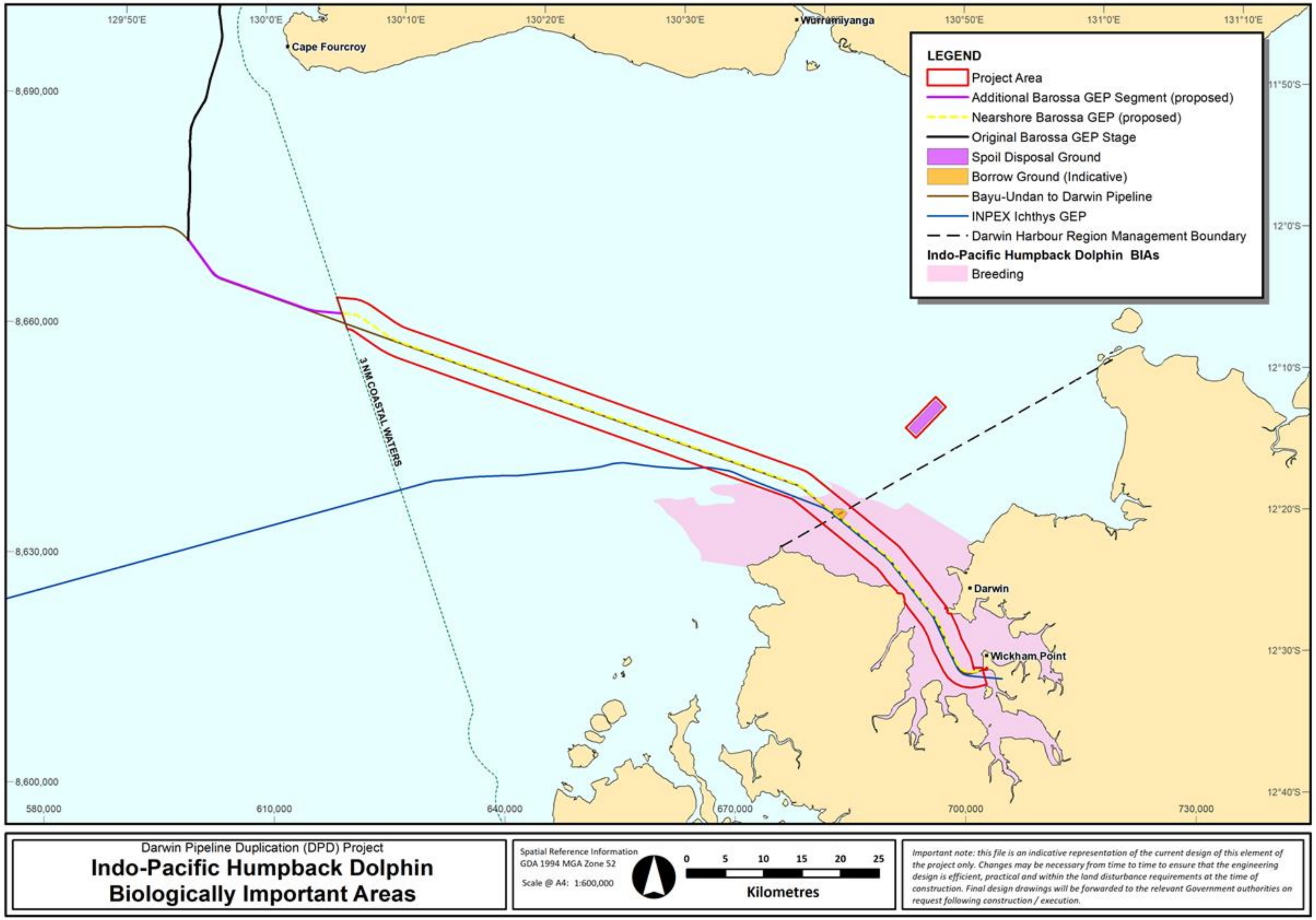


Figure 7-12 Biologically Important Areas for marine mammals – Indo-Pacific Humpback Dolphin

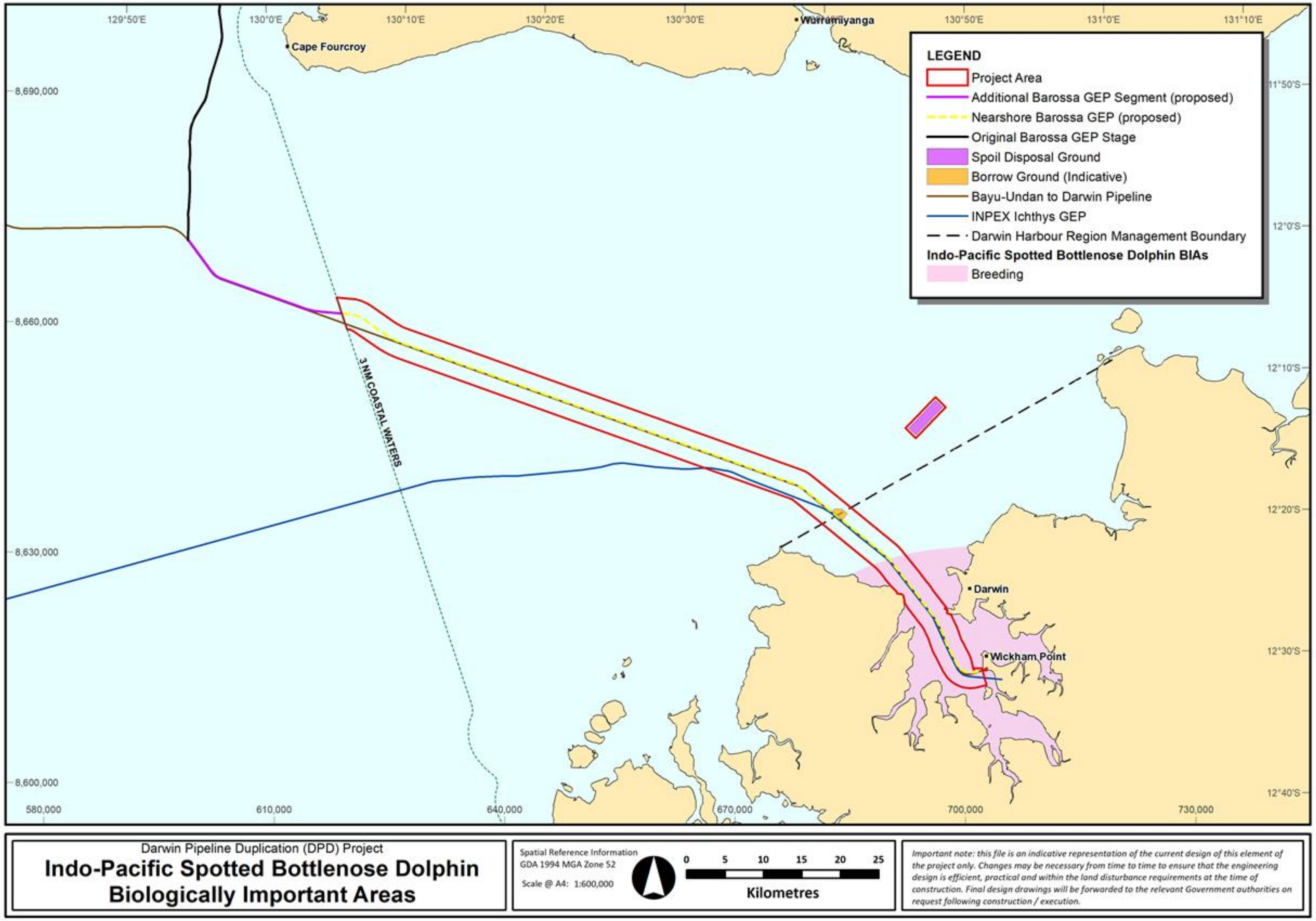


Figure 7-13 Biologically Important Areas for marine mammals – Indo-Pacific Spotted Bottlenose Dolphin

7.2.4.3 Fish and Sharks

The North Marine Bioregional Plan (DSEWPaC, 2021a) provides a summary of fish species inhabiting Commonwealth and NT waters within the NMR. A description of fish species within Darwin Harbour is provided in the Ichthys EIS (INPEX Browse, Ltd, 2010a) and this information is supplemented with data collected from fish monitoring programs associated with the Ichthys NEMP (INPEX Browse, Ltd, 2018).

A search of the DAWE National Conservation Values Atlas did not identify any threatened fish or shark species within the Project Area (DAWE, 2021b), while a search of the DAWE Protected Matters Search Tool (PMST) (**Appendix E**) identified 28 marine fish species (or their habitat) that may occur within 5 km of the Project Area (DAWE, 2021a). All listed fish species belong to the Syngnathidae (pipefishes and seahorses) and related Solenostomidae (ghost pipefishes) families, most species of which inhabit sheltered areas within coral reefs and seagrass beds. The search also identified seven threatened shark species (or their habitat) known to occur within 5 km of the Project Area (DAWE, 2021a), including three species of sawfish from the family Pristidae; further information of these three sawfish species is provided below.

Within Commonwealth and NT waters of the NMR, higher order predatory fish including snappers, emperors and groupers are common to rocky reef and coral habitats (DSEWPaC, 2012a). Demersal fish, including a number of commercially important species, in the NMR include trevallies, giant queenfish, barramundi, grunters, emperors, snappers, blue salmon, king threadfin and black jewfish and 61 species of pelagic fish species have been recorded (DSWEPaC, 2012a). Of the pelagic fish species, Longtail tuna, Grey mackerel, Spanish mackerel, Mackerel tuna, Black pomfret, and Spotted mackerel contribute approximately 90% of commercial catch in the NMR (DSWEPaC, 2012a). In the coastal areas of the NMR, fisheries trawl data have identified 460 teleost (boned) and 56 elasmobranch (cartilaginous) fish species (DSWEPaC, 2012a).

In Darwin Harbour, fish occupy a wide range of habitats, with the harbour supporting an abundance of resident and transient species with 415 species documented (INPEX Browse, Ltd, 2010a; Larson & Williams 1997 in INPEX Browse Ltd, 2018). Fish within the harbour are diverse, ranging from small gobies, cardinals and pipefish (approximately 70, 20 and 19 species, respectively) to commercially and recreationally important species of trevallies, mackerel, salmon, grunter, and barramundi (INPEX Browse, Ltd, 2010a). Juveniles of these latter species utilise mangrove habitats within the harbour, which are also occupied by a large number of other fish, particularly during high tides (INPEX Browse, Ltd, 2010a).

While barramundi (*Lates calcarifer*) is the most targeted species by recreational anglers throughout the NT (accounting for 26% of total catch), in Darwin Harbour it only accounts for 5% of total catch (Cardno, 2015 in INPEX Browse, Ltd, 2018). Golden snapper (*Lutjanus johnii*) is the second most targeted species, while Black jewfish (*Protonibea diacanthus*) is also commonly targeted by anglers in Darwin Harbour (Cardno, 2015 in INPEX Browse, Ltd, 2018).

Barramundi spawn in bays and river mouths with peak spawning between October and December. Juvenile barramundi follow tidal movements into mangrove and wetland habitat and into freshwater billabongs towards the end of the wet season. Given the limited access to freshwater billabongs in Darwin Harbour, juvenile barramundi are likely to remain in the coastal and estuarine waters in and around the harbour.

The three protected sawfish species listed on the PMST search results (**Appendix E**) are known to occur within Darwin Harbour are the Dwarf sawfish (*Pristis clavata*), Freshwater sawfish (*Pristis pristis/Pristis microdon*) and Green sawfish (*Pristis zijsron*).

The dwarf sawfish generally occur in shallow waters (2-3 m) in coastal and estuarine areas of tropical Australia, extending some distance up rivers almost into freshwater. In the Northern Territory, it has been recorded in several catchments, including the Keep River, Victoria River, South Alligator River and in Buffalo and Rapid Creek located in Darwin Harbour (DLRM, 2012).

The freshwater sawfish generally occur in waters >1 m, preferring muddy substrate in the upper reaches of estuaries and freshwater areas. It is primarily a marine/estuarine species, that spends its first 3 to 4 years in freshwater. In the Northern Territory, it has been recorded in a number of rivers including the Victoria River, Darwin River, Adelaide River, East and South Alligator River (NRETAS, 2006b).

The green sawfish is the most commonly encountered sawfish species in Australian tropical waters. It occurs in shallow waters in areas with a muddy substrate. The species has been reported to inhabit marine inshore waters, estuaries, lagoons and freshwater, but most records are from marine and estuarine areas. In the Northern Territory, it has only been recorded in Buffalo Creek in Darwin Harbour (NRETAS, 2006c).

7.2.4.4 Seabirds and shorebirds

Fifty-one species of bird are known to occur in the NMR including at least 43 seabird species listed under the EPBC Act. Of these, the region is considered to be particularly important for the following four species listed as migratory marine species; the Bridled tern (*Onychoprion anaethetus*); Roseate tern (*Sterna dougallii*); Brown booby (*Sula leucogaster*); Lesser frigatebird (*Fregata ariel*) (DSEWPaC, 2012a). While substantial proportion of the population of these four species use the region and adjacent waters and islands for breeding, nesting, foraging and other life history phases there are no BIAs for these species in the Project Area (DAWE, 2021b; DSEWPaC, 2012a).

A search of the DAWE National Conservation Values Atlas did not identify any seabird BIAs within the Project Area (DAWE, 2021b) with the closest BIA being for the Crested tern, around the northern end of the Tiwi Islands. A search of the PMST identified a number of seabird and migratory shorebird species that may occur within the Project Area, 13 of which are listed threatened species (**Appendix E**).

Of the 37 species of migratory shorebirds that regularly visit Australia (DoE, 2015b; Lilleyman et al, 2018), 25 of them occur along the coastlines of Darwin Harbour which has a variety of coastal habitats that migratory shorebirds use during the non-breeding season (Lilleyman et al, 2018). This includes natural sites such as beaches, rocky reefs, intertidal sand and mud flats, but also an artificial site – the dredge spoil disposal ponds at Darwin Port's East Arm Wharf.

Lilleyman et al, (2018) undertook aerial surveys of Darwin Harbour and recorded 724 individuals of 19 species of bird during the low tidal phase of the survey and at high tide recorded 789 individual shorebirds belonging to 13 species. The study was focused on the Far Eastern curlew (*Numenius madagascarensis*), two flocks of which were identified in numbers that meet the threshold for protection of threatened shorebirds under the EPBC Act. One flock was recorded at East Arm Wharf, where large congregations assemble frequently. The other flock was at a saltpan, south-east of East Arm Wharf, adjacent to the Darwin LNG Plant (although it was noted that this roosting site may not be available at the highest tides) (Lilleyman et al, 2018).

Shorebird monitoring has been undertaken at East Arm Wharf and the dredge spoil disposal ponds in accordance with a migratory bird monitoring plan for the East Arm Wharf since 2009 (URS, 2014). The East Arm Port area has been identified as supporting nationally important migratory shorebird habitat based on it meeting several criteria for migratory shore birds (e.g., observed fly away population criteria) such as the lesser sand plover, greater sand plover, far eastern curlew, terek sandpiper and sharp-tailed sandpiper (Chatto 2003 and Lilleyman, 2013; in URS, 2014). This site regularly provides safe roosting habitat for over 1000 shorebirds of 25 species plus 45 species of other waterbirds or water-associated birds (Lilleyman et al, 2018).

7.2.5 Reef Protection Areas

The Project pipeline within Darwin Harbour intersects the Charles Point Reef Protection Area (RPA) (NT) and is relatively close proximity to the Lorna Shoal RPA (approximately 9 km to the east) (refer **Figure 7-13**). No fishing activities are permitted within RPAs and as the protection of these areas is to prevents over-fishing of Golden snapper, Black jewfish and other vulnerable reef species.

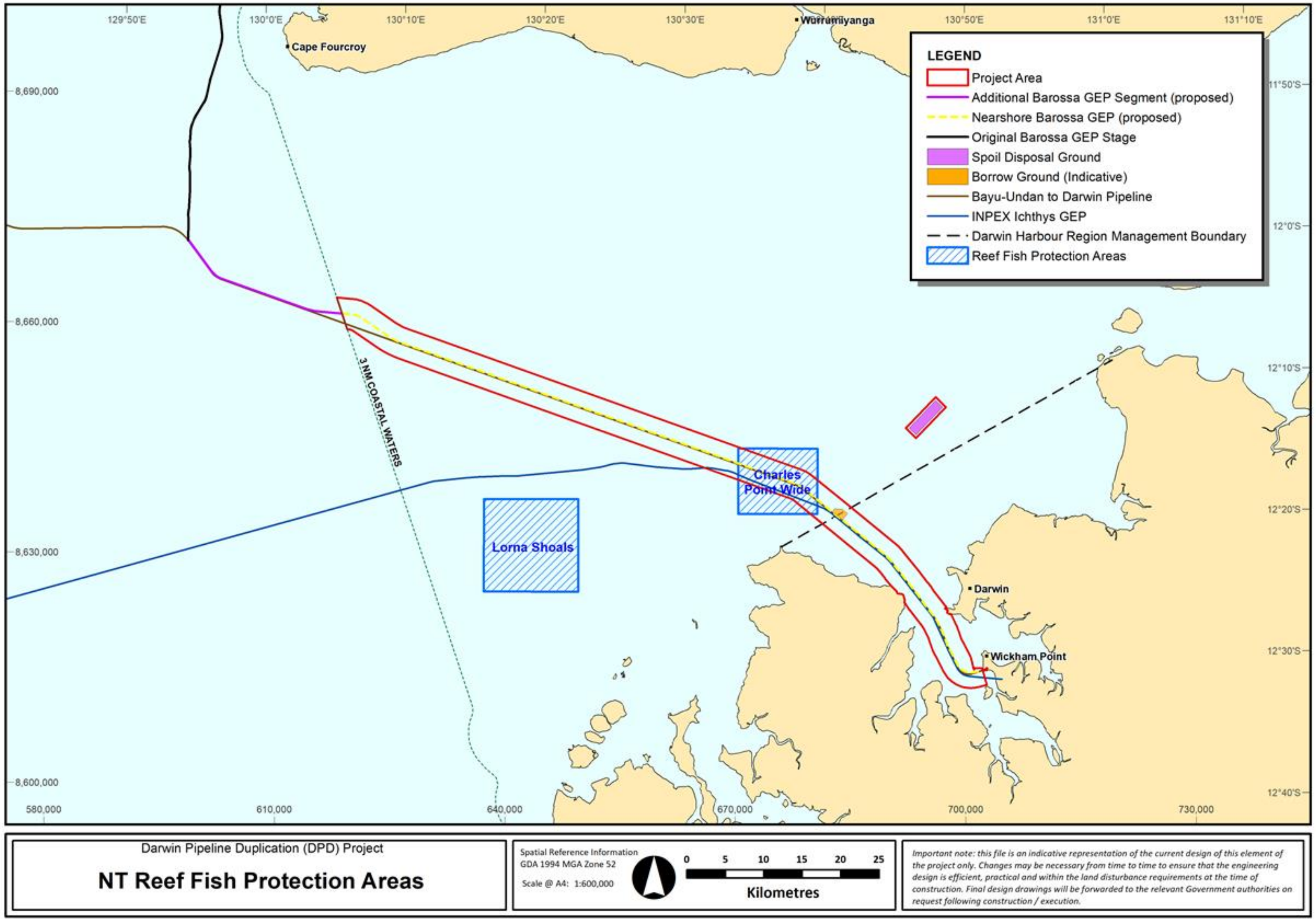


Figure 7-14 NT reef protection areas

7.3 Terrestrial environment

7.3.1 Bioregion

Bioregions are geographically distinct areas of land with common characteristics such as geology, landform patterns, climate, ecological features and plant and animal communities.

The Project Area is located within the Darwin Coastal Bioregion (Environment Australia, 2000). The Bioregion includes:

+ A total area of 27,800 km2;
+ The western coastline of the NT;
+ A landscape that is generally flat, low lying and drained by several large rivers;
+ Vegetation communities including eucalypt forest and woodlands with tussock and hummock grass understorey;
+ Mixed land use with urban development;
+ Major population centres Darwin and Palmerston;
+ A tropical monsoonal climate;
+ Numerous threatened species;
+ More than 15% of the bioregion is protected; and
+ Several weeds.

7.3.2 Land units

The Darwin Coastal Bioregion is generally flat, low-lying country, drained by several large rivers. Based on local Darwin Topography maps, the shore crossing area ranges in level from about relative level (RL) 3m Australian Height Datum (AHD) to approximately RL 9m AHD. The majority of the Project Area is mapped as having a slope less than 2%.

Land unit mapping for the Darwin area provides an overview of the land units relevant to the onshore component of the Project Area. Noting that the majority of the peninsula is a built and developed site, the land unit information will concentrate on the fringing environments that have not been disturbed.

Consistent with the site's topography, Land unit mapping indicates the terrain in the Project Area includes rises and marine. Soil groups across the area also vary with the varying land units and generally include Kandosols in the higher landscapes and Hydrosols in the lower landscapes.

The Littoral land system covers the remainder of the two land parcels, and previously formed a fringe of tidal mudflats around Quarantine Island (Acer Vaughan, 1993). The Littoral land system has negligible relief and slope and is subject to tidal inundation, with mangroves and salt flats lying over muddy soils formed by sedimentary progradation (Acer Vaughan, 1993). The mangrove muds comprise clays and silts that would likely have a low bearing capacity and potential for encountering acid sulphate soils.

7.3.3 Flora, vegetation communities and weeds

7.3.3.1 Flora

A search on the Department of Environment, Parks and Water Security (DEPWS) Natural Resource (NR) Maps Database, listed species in Darwin Harbour Sites of Conservation Significance (SoCS) Factsheet for threatened flora species within a 5 km radius of the Project pipeline. A summary of the search is provided in **Table 7-1**.

Earlier investigations completed for the DLNG facility (within which the onshore components of the Project are wholly contained) to support both the DLNG EIS and the DLNG Transitional Work Program Notice of Intent (NOI), did not identify the presence of any threatened or conservation significant flora species.

Table 7-1 Flora species of conservation significance

Common Name	Scientific Name	Status		Description and likelihood	Likelihood
		TPWC Act	EPBC Act		
Hibiscus	*Hibiscus brennanii*	VU	Not listed	A subshrub with wiry branches that grows to 0.3 m high, of a low spreading, somewhat delicate habit. This species is endemic to the NT, where it is very localised in a small protected area straddling the boundary between Kakadu National Park (KNP) and Arnhem Land. It is known only from a single northern sandstone outlier of the Western Arnhem Land escarpment. Therefore it is extremely unlikely to occur in the vicinity of the Project Area.	Unlikely
Bladderwort	*Utricularia singeriana*	VU	Not listed	A small to medium sized, terrestrial bladderwort. This species is a NT endemic. It was previously regarded as occurring in WA but recent research shows	Unlikely

				that the only WA specimen was misidentified and the species is endemic to NT.	

7.3.3.2 Vegetation communities

Vegetation on the Middle Arm Peninsula and inland of Darwin is consistent with the Darwin Coastal Bioregion, classified as a various closed forest and woodland communities, dominated by mixed acacia forest and eucalyptus woodlands (DAWE, 2007). Lowland vegetation types include paperbark (*Melaleuca spp*.) forest, grassland and heathlands (NPEX Browse Ltd, 2010a, ConocoPhillips, 2019a).

No threatened ecological communities were recorded in the surrounds of the DLNG facility based on the EPBC Protected Matters search (DAWE, 2021a). The previously cleared DLNG site has areas of vegetation re-growth present.

A targeted vegetation survey of the shore crossing disturbance area conducted in November 2021 by a qualified and experienced botanist from CDM Smith, confirmed the presence of only one species of mangrove in proximity to the Project Area*, Sonneratia alba*, of which there were only a handful of individuals (i.e. less than 5 plants within 20 m either side). This species of mangrove (*S. alba*) is a common taxon that is well represented and characterised as part of the mangrove monitoring programme at DLNG. **Figure 7-15** shows a singular S. alba situated within the intertidal area of the DLNG facility disturbance envelope and within proximity of the Project pipeline. The survey confirmed that the shore crossing location forms part of the existing and maintained cleared lands within the existing DLNG facility disturbance envelope. **Figure 7-15** shows the view of existing clearing and access road, noting the DLNG permitter fenceline on the right (north) and uncleared vegetation margin 20-30 m on the left (south).


Figure 7-15 View of existing cleared shore crossing looking west toward Darwin Harbour (Left) and S. alba in proximity of the shore crossing within the intertidal area of DLNG facility disturbance envelope (Right)

7.3.3.3 Weeds

There are three main categories of noxious weeds defined under the Weeds Management Act 2001 (WMA), which include:

+ Class A – To be eradicated;

+ Class B – Growth and spread to be controlled; and
+ Class C – Not to be introduced to the Northern Territory. All Class A and B weeds are also considered to be Class C weeds.

In addition to this, 32 Weeds of National Significance (WoNS) have been agreed by Australian Governments based on an assessment process that prioritised these weeds based on their invasiveness, potential for spread and environmental, social and economic impacts. Consideration was also given to their ability to be successfully managed.

A desktop assessment was undertaken reviewing the EPBC Act Protected Matters Report (**Appendix E**) and DEPWS NR Maps (DEPWS, 2021a;b) which indicated 20 weed species declared under the WM Act or EPBC Act with potential to occur within the Project Area, 13 are WoNs declared. Weeds at the DLNG facility are currently managed as part of the DLNG Operations Environmental Management Plan (OEMP). Given the shore crossing is located within the previously disturbed DLNG facility disturbance envelope, weeds for this Project would be managed according to the requirements of the existing DLNG OEMP.

7.3.4 Fauna and habitat (including introduced species)

7.3.4.1 Threatened and significant species

There are a number of threatened fauna species, listed under both the Commonwealth EPBC Act and the Territory Parks and Wildlife Conservation Act 2001 (NT) (TPWC Act), which may be present in the shore crossing surrounds, as described in the following section (EPWS, 2021c). However, given the shore crossing location has been previously disturbed (i.e. wholly within the existing DLNG disturbance envelope), it is expected that no significant fauna habitats would be affected.

7.3.4.2 Fauna species and habitat

Five fauna habitat types were recognised and described at the shore crossing as part of the DLNG EIS (Philips Oil Company Australia, 1997). These include eucalyptus open forest; mangroves, margins and samphire; monsoon rain forest; paperbark woodland; and intertidal flats. The DLNG Transitional Work Program NOI provides an overview of the fauna species with the potential to occur at the shore crossing location, as summarised in **Table 7-2.**

Table 7-2 Fauna species potentially occurring at the shore crossing

Species	Description
Mammals	Fifteen mammal species (including two introduced species) have been recorded at Wickham Point during field surveys in September 1996 and February 1997. The Northern brown bandicoot (*Isoodon macrourus*) is a common species at Wickham Point. agile wallabies (*Macropus agilis*) are occasionally observed around the mangrove fringes and their tracks are seen on the samphire flats. *Microchiropteran* (insectivorous) bats have been recorded frequently in Eucalyptus open forest, over tributaries and water bodies and using flyways on mangrove/open forest ecotones. Flying

	Foxes (*Pteropus alecto*) are occasionally observed in mangrove areas.
Fish	There are no permanent freshwater habitats on Wickham Point or the adjacent mainland peninsula. Wet season freshwater habitats are present in some areas of the mainland peninsula. It is likely that these seasonal freshwater areas provide breeding sites for some estuarine and coastal freshwater fishes.
Reptiles	Eleven species of reptiles have been recorded for the site, including one species of crocodile, and 10 lizard species. The most commonly recorded species are small skinks of the genus Carlia, of which three species have been observed. *Carlia munda* was the most abundant, and was found in all non-marine habitats. *Carlia amax* was only observed around rocky areas in the monsoon vine thickets. Two skinks, *Glaphromorphus darwiniensis* and *G. douglasi*, were observed to be generally confined to the monsoon vine thickets and paperbark forest habitats.
Amphibians	All recorded frog species have been found in Eucalyptus open forest during the wet season. Frogs are common in waterlogged areas with sedges. The most common species are Brown tree frog (*Litoria rothi*) and Dwarf tree frog *(L. bicolor*).
Birds	Ninety species of birds have been recorded in the study area during field surveys. An additional 93 species are known to occur in Darwin Harbour. These are likely to be present at Wickham Point. The birds most commonly observed during previous surveys include Bar-shouldered dove (*Geopelia humeralis*), Sulphur-crested cockatoo (*Cacatua galerita*), Helmeted friarbird (*Philemon buceroides*) and Yellow oriole (*Oriolus flavocinctus*). More bird species (57 species) were observed in mangrove-associated habitats than in any of the other habitats. The next richest habitat was Eucalyptus open forest. A great deal of seasonal variation was observed in bird species composition and numbers between two field surveys undertaken in the vicinity on the DLNG facility site in September 1996 (dry season survey) and February 1997 (wet season survey). Similar numbers of species were observed in each seasonal survey (67 in the dry; 62 in the wet), but only 38 species were recorded on both field surveys, indicating the area has a very high proportion of transient or seasonal migrant species compared to residents. These species are made up of groups such as migratory waders and other wet season visitors. A number of wet season visitors have been recorded during September, which is the usual time for the arrival of seasonal migrants. Large nesting mounds of the Orange-footed scrubfowl are a prominent feature of Wickham Point.

7.3.4.3 Introduced species

Results of the desktop searches of EPBC Act Protected Matters Report (**Appendix E**), DEPWS NR Map and SoCS Factsheets indicate that several pest species are likely to occur within 5 km of the shore crossing, location including; cats, wild dogs, cane toads and Browsing ants (*Lepisiota frauenfeldi*). These species are expected to occur in relatively low numbers and were likely established before construction of the DLNG facility.

The Port of Darwin has been determined to be free of introduced marine pest species, with the exception of a Sea squirt (*Didemnum perlucidum*) which was confirmed during surveys undertaken for the construction of the Ichthys LNG facility.

7.3.4.4 Biting insects

The Middle Arm Peninsula is subject to large numbers of biting insects such as midges and mosquitoes due to the proximity of the mudflat and mangrove breeding sites along Hudson Creek, Bleesers Creek and the peninsula shoreline (Department of Health, 2011).

Breeding sites are common on constructed surfaces, such as stockpile hardstands and ponds along the peninsula. The Middle Arm Area contains numerous mosquito breeding sites created by the original development, with notable sites including the large mud ponds, shallow depressions on reclaimed land, shallow depressions on an extensive site used for borrow material, small sediment traps and numerous drainage lines.

Studies show that the northern salt marsh mosquito *Aedes vigilax* and the common banded mosquito *Culex annulirostris* occur in seasonally high numbers at Middle Arm (Warchot and Whelan 2010).

The northern salt marsh mosquito is typically recorded in very high numbers during the wet season months of December and January, whereas the common banded mosquito is generally recorded in high numbers in January to April. Most salt marsh mosquito breeding sites would also be considered as common banded mosquito breeding sites, with breeding occurring once prolonged flooding of over 7 days occurs.

7.4 Socio-economic environment

7.4.1 Commercial shipping

Vessel traffic data from the AMSA Marine Traffic Database (AMSA, 2021) for the Project Area during March 2021 is shown in **Figure 7-16**, which shows the Project Area intersects areas of high shipping traffic.

Shipping traffic in the offshore NT waters of the Project Area is relatively light however, at the approach to Darwin Harbour, and within the harbour itself, several notable shipping traffic lanes converge to create a high-density shipping traffic area that overlaps with the Project Area.

The Port of Darwin recorded 2,154 vessel visits in 2018-19 (Darwin Port Authority, 2019) with traffic in the Port typically influenced by number of the well-established industrial and commercial facilities that receive a wide of maritime traffic (i.e. cargo, livestock vessels, LNG tankers and cruise ships).

Whilst 61 cruise ships visited Darwin Port in 2020-21, with the majority travelling between South-East Asia and the eastern coast of Australia, this number dropped significantly with the onset of the Covid-19 pandemic. Regional commercial shipping activities are also associated with support and supply vessels servicing oil and gas offshore facilities. For example, in 2020-21, there were 283 rig tender vessel calls to Darwin Port facilities. The Port forms the main base for oil and gas contracted supply vessels that support northwest Australia offshore activities (Darwin Port Authority, 2019).

Although Darwin Port remains the primary active port in the region, there is small-scale port activity at the Tiwi Islands. Port Melville is located on Melville Island (122 km north of Darwin) and the wharf infrastructure at Port Melville was constructed in 2013. Shipping traffic associated with the route between Darwin Port and the Tiwi Island, including Port Melville, is shown in **Figure 7-16.**

7.4.2 Darwin Harbour uses

The most intensive use of Darwin Harbour is commercial shipping, recreational boating and fishing, tourism and naval activities. East Arm Port is to the northeast of Wickham Point. It is a significant active Port development used by a range of maritime industries.

The last Territory-wide recreational fishing survey was undertaken in 2009-2010. The survey reported a high-level of recreational fishing effort in the NT with effort totalling in the order of over 150,000 days and is mostly boat-based (81%) (West et al, 2012). Darwin Harbour accounted for 27% of the total fishing effort in the NT (West et al, 2012). The most commonly caught species include barramundi, various snapper species, baitfish, catfish and mud crabs (SKM, 2011).

Fishing tourism is important to the NT's economy and there are several fishing clubs throughout the NT, who utilise the harbour.

Santos

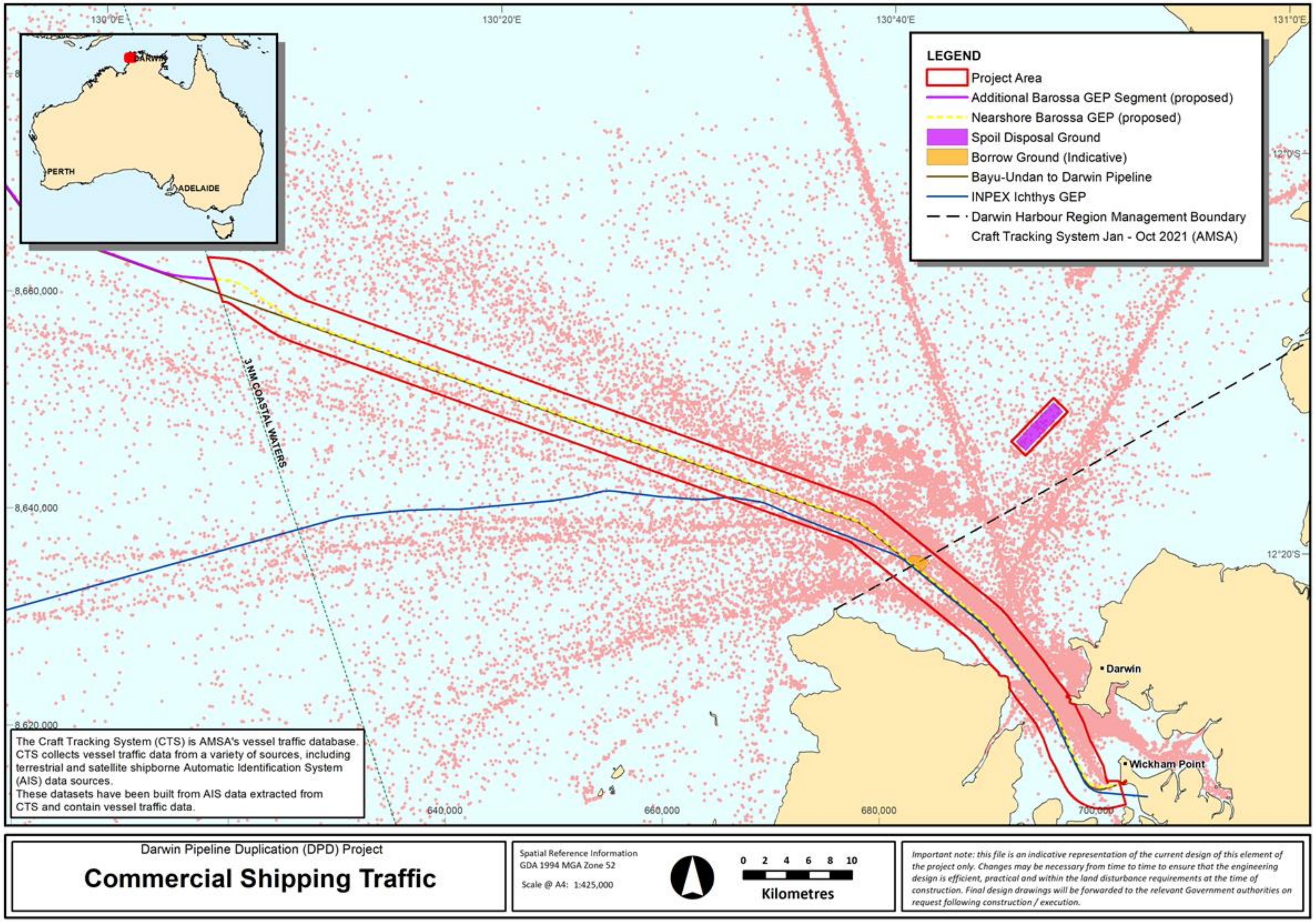


Figure 7-16 Commercial shipping traffic

7.4.3 Commercial fisheries

7.4.3.1 Commonwealth fisheries

The Northern Prawn Fishery is the only active Commonwealth managed fishery that operates within the Project Area. While three other Commonwealth managed fisheries overlap the Project Area, e.g. the Southern Bluefin Tuna Fishery, the Western Tuna and Billfish Fishery and the Western Skipjack Tuna Fishery, these have been excluded from the assessment given these fisheries are either inactive or operate at extremely low levels within or nearby to the Project Area (i.e. less than five vessels active in the fishery each year since 2005 (DoAWR, 2016).

The Northern Prawn Fishery management area extends from Cape York in Queensland and Cape Londonderry in WA; from the low water mark to the outer boundary of the Australian Fishing Zone (AFZ) (refer **Figure 7-17**). The majority of the fishing effort within the Northern Prawn Fishery occurs in the area of the Gulf of Carpentaria, Joseph Bonaparte Gulf and along the Arnhem Land coast with the highest catches coming from areas adjacent to mangrove forests and coastal seagrass beds, which are juvenile nursery areas for target species of the fishery (Patterson et al, 2016). Fishing is conducted using bottom trawl nets and is managed through a number of standard fishery controls (Patterson et al, 2016). All vessels use electronic navigational aids including echo sounders and GPS systems and are required to have a vessel monitoring system installed (Laird, 2018). While fishing season durations are regularly adjusted, to account for expected or observed changes in fishing effort and catches for example, in 2012, 2013, 2014 and 2015 the banana prawn season was open from 1st April to 15th June, and the tiger prawn season was open from 1st August to 30th November (Laird, 2018).

The total Northern Prawn Fishery catch for 2018 was 6,763 tonnes compared to 6,545 tonnes in 2017 (Laird, 2019). Catch and effort for the fishery is partitioned into 15 statistical areas. The Project Area falls mostly within the defined Fog Bay statistical area in which the catch and effort in 2018 for banana prawns was 230 tonnes and 162 days respectively and 0.1 tonnes and 1 day of effort for tiger prawns (Laird, 2018). The fishery is expected to be active around the Project Area during the permitted fishing seasons.

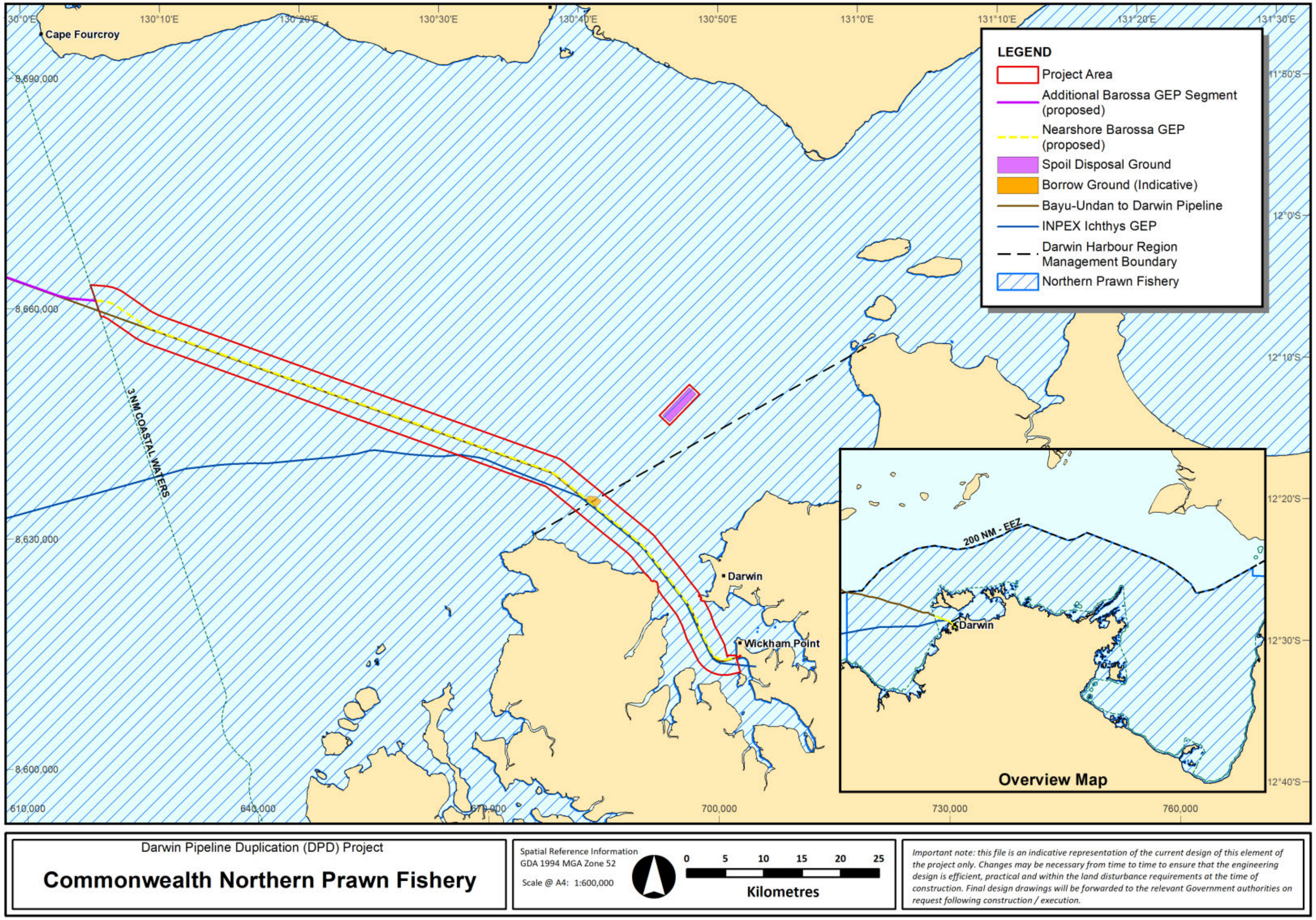


Figure 7-17 Commonwealth fisheries – Northern Prawn Fishery

7.4.3.2 Northern Territory fisheries

The NT Aquarium Fishery industry is a small-scale, multi-species fishery. It includes freshwater, estuarine and marine habitats to the outer boundary of the AFZ, which is 200 nautical miles offshore. Freshwater and estuarine species are generally collected between the Adelaide and Daly rivers, while most marine species are collected within 100 km of Nhulunbuy and Darwin, and the fishery is therefore active within the Project Area. Licensees employ several types of nets, hand pumps, freshwater pots, and hand-held instruments to collect specimens. The aquarium fishery supplies a wide range of aquatic life to local, interstate and international pet retailers and wholesalers. This includes aquarium fishes (mostly rainbowfish, catfish and scats), invertebrates (i.e. hermit crabs, snails, whelks and hard and soft corals) and plants.

The Offshore Net and Line Fishery covers an area of over 522,000 km2 and extends from the NT high water mark to the boundary of the AFZ (Northern Territory Government, 2021a). The fishery includes Australian Blacktip Sharks (*Carcharhinus tilstoni*), Common Blacktip Sharks (*C. limbatus*) and Grey Mackerel (*Scomberomorus semifasciatus*) (Northern Territory Government, 2021). The fishery permits pelagic gillnets and longline gear. Demersal longlines can be used throughout the fishery whereas pelagic gillnets and pelagic longlines can only be used beyond 2 nm and 3 nm off the coast, respectively. Pelagic gillnets are the primary gear used by this fishery and are generally set within 15 nm of the coast. Most of the fishing effort is in the coastal zone (within 12 nm of the coast) and immediately offshore in the Gulf of Carpentaria (Northern Territory Government, 2021a. There is potential for fishing to occur in or proximate to the Project Area. Stakeholder consultation undertaken by Santos (2021) for the Barossa GEP identified one licence holder that may fish off the south-west end of the Tiwi Islands for small pelagic fish.

The Spanish Mackerel Fishery extends from the high-water mark of NT waters to the outer limit of the AFZ and targets Spanish Mackerel (*Scomberomorus commerson*) (DoAWR, 2016). The fishery employs troll lines, floating handlines and rods. Primary fishing effort occurs in the vicinity of reefs, headlands and shoals and includes waters near Bathurst Island, New Year Island, the Wessel Islands around to Groote Eylandt and the Sir Edward Pellew Group of islands (DoAWR, 2016). In 2012, there were 16 fishery licences of which 12 were actively operating. The 2012 fishing effort was 719 boat-days; a decrease from 813 boat-days in 2011 but an increase from the 672 boat days in 2010. There is potential for fishing to occur within, or within close proximity to, the Project Area. As part of consultation undertaken by Santos (2021) for the Barossa GEP, stakeholders advised that there is the potential for fishing to occur within the southern extent of the original Barossa GEP.

The Coastal Line Fishery extends seaward from the high-water mark to 15 nm from the low water mark, covering the entire NT coastline and primarily targets Black Jewfish (*Protonibea diacanthus*) and reef species. The fishery is as two fishing zones, which divide the coastline at Vashon Head on the Cobourg Peninsula (DoAWR, 2016). The majority of fishing effort is focused around rocky reefs within 150 km of Darwin. Several gear types are permitted throughout the fishery, namely rod and line, hand lines, cast nets (for bait only), scoop nets and gaffs. Drop-lines and five fish traps may also be used beyond 2 nm from the coast though fish traps can only be used in the Eastern Zone of the fishery. Drop-lines comprised less than 0.8% of the total catch in 2017 (DoAWR, 2016). As activity within the fishery is concentrated in nearshore waters, there is potential for fishing to occur in proximity to the nearshore Project Area.

The NT Demersal Fishery extends 15 nm from the NT low water mark to the outer limit of the AFZ excluding the area of the Timor Reef Fishery. The fishery targets a range of tropical snappers (*Lutjanus* and P*ristipomoides* species) using a variety of gear. Fish traps, hand lines and drop-lines are permitted throughout the fishery and demersal trawl nets are permitted in two defined zones. Demersal Fishery licensees harvested 3388.8 tonnes of fishes in 2017. There are currently 18 licences issued for the fishery and it is managed through a number of standard fishery controls (Northern Territory Government, 2021b). Most of the fishing effort occurs in deep offshore waters along the eastern boundary of the Timor Reef fishery in water depths of 80-100 m. As such there is only a low potential for fishing to occur within the Project Area.

Locations of NT fisheries relevant to the Project Area are provided in **Figure 7-18**.

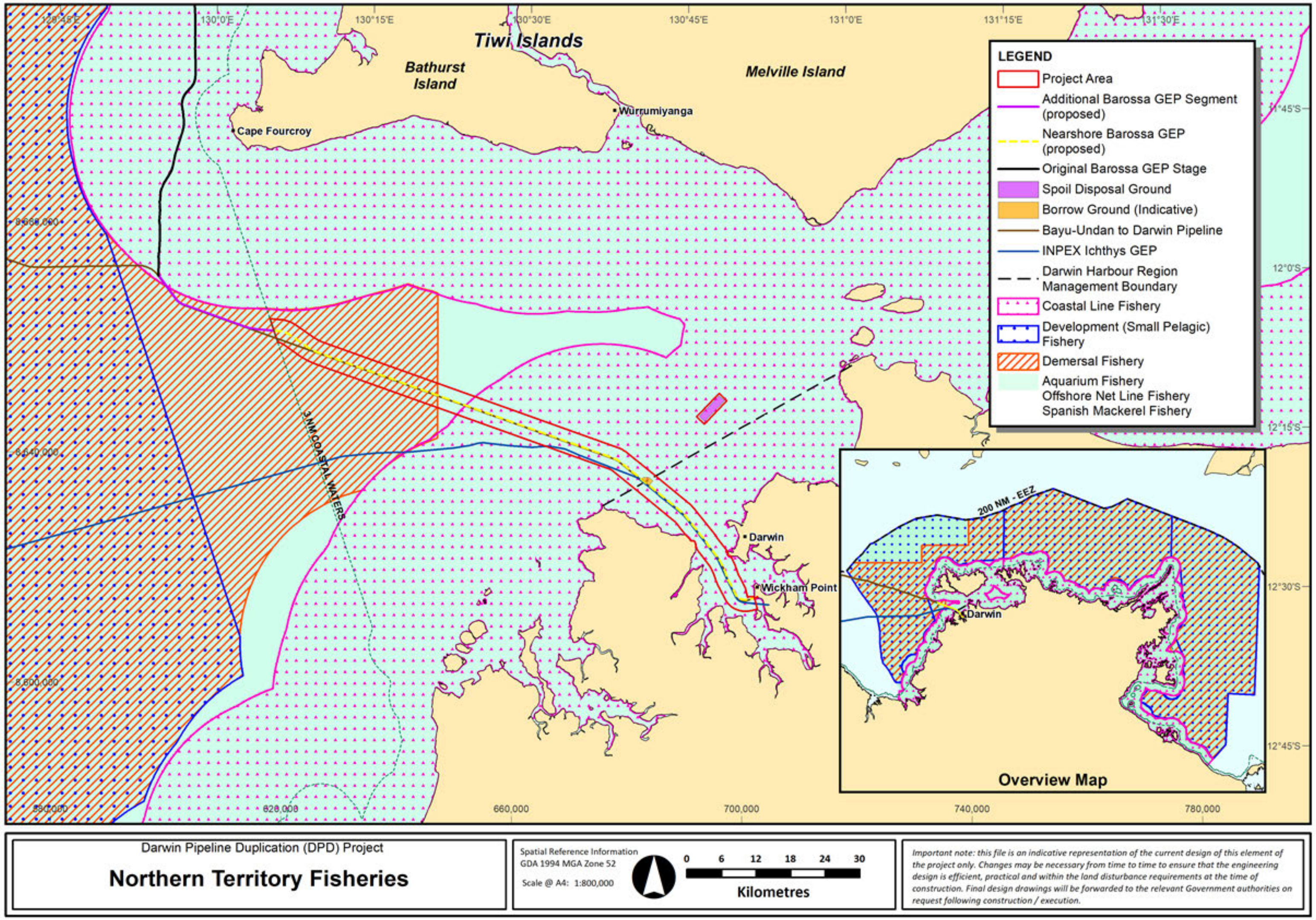


Figure 7-18 Northern Territory fisheries

7.4.4 Existing land uses and infrastructure

The NT Planning Scheme Darwin and Surrounds zoning map shows the area occupied by the DLNG facility at Wickham Point (Sections 1860 and 1870 to 1871, Hundreds of Ayers) is zoned for Future Development (Northern Territory Government, 2019c). Therefore the Project Area is within, and compatible with, the gazetted land use for the area.

Current land uses of Middle Arm Peninsula in the vicinity of the DLNG facility (relevant to the shore crossing of the Project Area) include:

+ The operational BOC Helium plant, which is located adjacent to DLNG;
+ Industrial land use at Channel Island (PWC power station, LPG storage and unloading facility, and the Darwin Aquaculture Centre);
+ INPEX Ichthys LNG plant at Bladin Point, to the east of Wickham Point (detailed further in **Section 7.4.4.1**);
+ Extractive industries to source aggregate for construction/development projects, to the east/south-east of DLNG; and
+ Recreational uses, reflecting the popularity of Darwin Harbour for recreational boating and fishing. Elizabeth River Bridge is a popular local fishing location, and a boat ramp for recreational boat users exists on Channel Island.

7.4.4.1 LNG plants – INPEX Ichthys and Santos DLNG

The two primary LNG facilities on Middle Arm Peninsula are the Darwin LNG Project operated by Santos, and the Ichthys LNG Project operated by INPEX. The Project pipeline will connect into the existing DLNG facility.

DLNG comprises of a gas processing facility which includes units for:

+ Gas receiving facilities (including beach valve, pig receiver and meter station for the Bayu-Undan to Darwin pipeline);
+ Acid gas removal;
+ Dehydration and mercury removal;
+ Propane and ethylene refrigeration; and
+ Liquefaction, methane compression and nitrogen rejection.

Both LNG facilities have been subject to extensive prior assessment and approvals, and ongoing operational monitoring and reporting.

7.4.4.2 Middle Arm Sustainable Development Precinct

The Land Development Corporation is progressing planning for the Middle Arm Sustainable Development Precinct, of which the DLNG facility and INPEX Ichthys LNG plant are a part. The industrial precinct will accelerate the development of Middle Arm Peninsula into a globally competitive, sustainable development precinct (Northern Territory Government, 2021c). The precinct also has an extensive product corridor for utilities, gas, feedstock and products. The following industries are proposed to be accommodated within the precinct:

- Energy;
- Carbon capture use and storage;
- Petrochemicals;
- Minerals processing;
- Hydrogen; and
- Advanced manufacturing.

The strategic development plan for the Middle Arm Sustainable Development Precinct is shown in **Figure 7-19** (Northern Territory Government, 2021c).

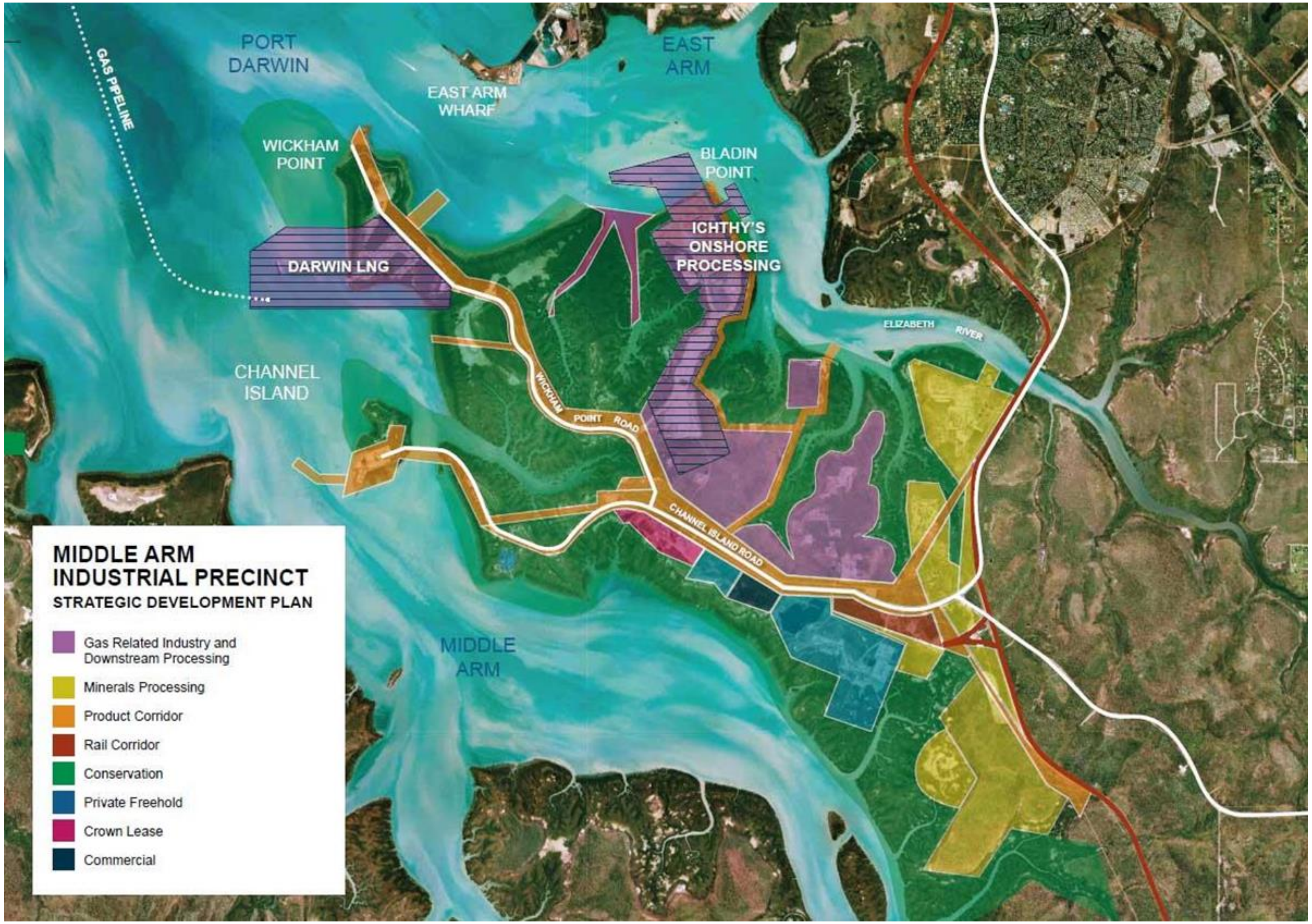


Figure 7-19 Middle Arm Sustainable Development Precinct

(Source: The Territory, Middle Arm Sustainable Development Precinct | Australia's Northern Territory (theterritory.com.au))

7.5 Sites of conservation significance

Darwin Harbour is recognised as an NT Site of Conservation Significance (SOCS Number 6) as it supports a range of estuarine, freshwater and terrestrial environments of ecological values, including extensive areas of tidal mudflats and a diverse area of mangroves (DEPWS, 2021a; Northern Territory Government, 2009). The SOCS encompasses the entire DLNG facility and surrounds.

Whilst the Project Area is located within the Darwin Harbour Site of Conservation Significance, there is no sensitive or significant vegetation or buffer areas located within the Project Area. The closest significant vegetation type to the Project Area are mangroves which are located either side of the shore crossing.

7.6 Defence

A search on National Map (DCA, 2021) was undertaken and identified that the Project Area intersects the Darwin Air Weapons Range (AWR) Central Defence Practice Area and is nearby to the Australian Exercise Area (NAXA) Defence Training Area (approximately 3 km to the south), as shown in **Figure 7-20**.

There are no defence areas within or adjacent to the Project Area (as required to be distant from the operational DLNG facility and associated infrastructure).

7.7 Tourism and recreational activities

In addition to providing a base for major Port operations in the NT, Darwin Harbour supports a range of commercial and recreational maritime uses, including fisheries, tourism and recreational shipping/boating activities. Limited tourism and recreational activities occur within the offshore NT waters of the Project Area.

The water surrounding Middle Arm Peninsula is used for recreational fishing, sailing and general boating. However, tour boats in Darwin tend to avoid the Middle Arm because of navigational hazards in the shallow nearshore waters (URS, 2002).

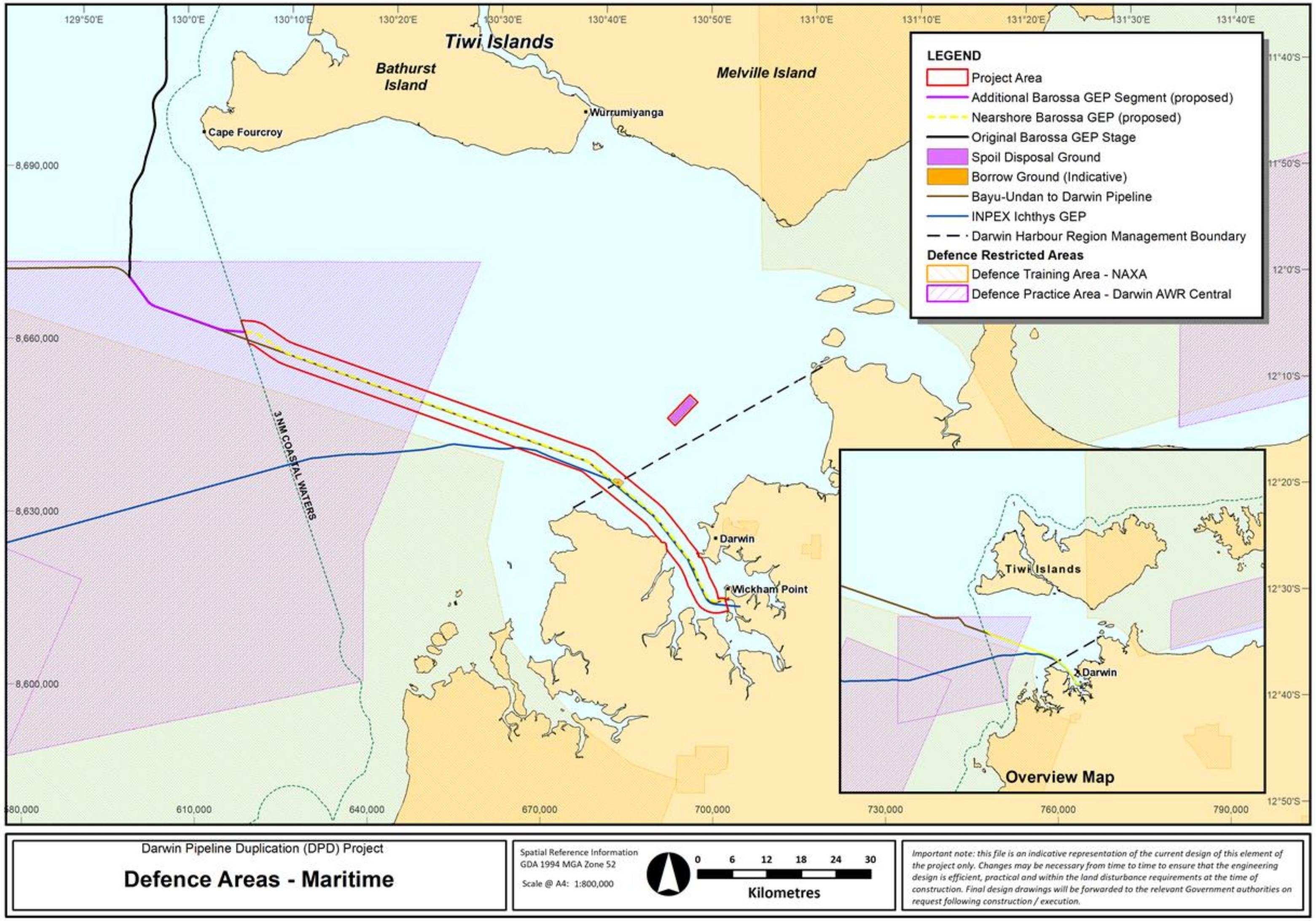


Figure 7-20 Defence areas – maritime

7.8 Cultural heritage

7.8.1 Maritime

The Northern Territory Heritage Register maintained by Heritage Branch, shows that the wreck of the *SS Ellengowan* is located close to the Project Area in Darwin Harbour (approximately 2 km east) as shown in **Figure 7-21** (Map A) (Northern Territory Government, 2019). This is the oldest known shipwreck in Darwin Harbour and is one of the earliest examples of shipping associated with European settlement in the area. It is a unique example of nineteenth-century maritime history in the territory and is the only known Norwegian-built iron steamer in Australian waters. Its significance to maritime archaeology is consequently rated highly (DNREA, 2008).

A protected zone may be declared around a shipwreck under the *Historic Shipwrecks Act 1976*, requiring a permit to enter. There are currently three protected zones with closed water orders in the NT:

+ Japanese submarine I-124, lost off Bathurst Island in 1942;
+ Florence D, sunk by Japanese aircraft off Bathurst Island in 1942; and
+ Sanyo Maru, sunk in a storm off the Arnhem Land coast in 1937.

There are also currently two sites in Darwin Harbour that have 'closed waters' controls over them by order of the regional harbourmaster - the Booya and Catalina 6. These areas can't be entered without permission of the Heritage Branch.

A search on the Australian National Shipwrecks Database (DAWE, 2021c) identified a number of shipwrecks nearby to the Project Area, particularly within Darwin Harbour. Five historic shipwrecks listed under the Commonwealth *Underwater Cultural Heritage Act 2018* are overlapped by the Project Area, these being (refer to **Figure 7-21):**

+ Japanese submarine I-124, sunk in 1942 west of Bathurst Island (800 m radial protection zone);
+ Yu Han 22, unknown vessel wreck within Darwin Harbour (protection zone not provided);
+ Song Saigon, a motor vessel wrecked in 1982 within Darwin Harbour (protection zone not provided);
+ Mauna Loa USAT, a twin screw steamer wrecked in 1942 within Darwin Harbour (100 m radial protection zone); and
+ Meigs USAT, a twin screw steamer wrecked in 1942 within Darwin Harbour (protection zone not provided).

There are no World, National or Commonwealth Heritage places within or in close proximity to the Project Area.

The route selection process undertaken as part of the Project planning, with intention to follow the existing corridor, has enabled the project to avoid interference with these heritage sites. Engagement with the Heritage Branch is underway to confirm if additional heritage sites are present within the Project Area.

7.8.2 Native title

All Native Title claims over the Project Area (land and water) were extinguished (Risk vs Northern Territory of Australia, Federal Court NTD6033/01). It is unlikely that any future claims will be made over the same area and if so, it is unlikely that the claim will be successful.

7.8.3 Indigenous

Aboriginal sacred sites are protected by the Northern Territory Aboriginal Sacred Sites Act 1989 (NT). Sacred sites are places within the landscape that have a special meaning or significance under Aboriginal tradition. Hills, rocks, waterholes, trees, plains, lakes, billabongs and other natural features can be sacred sites. In coastal and sea areas, sacred sites may include features which lie both above and below the water (AAPA, 2020).

[redacted]

Santos will continue to engage with AAPA to ensure the requirements of the Aboriginal Sacred Sites Act are met

7.8.4 European

No European heritage is currently listed at Wickham Point, with the remnants of artefacts documented and removed prior to the construction of the DLNG facility.

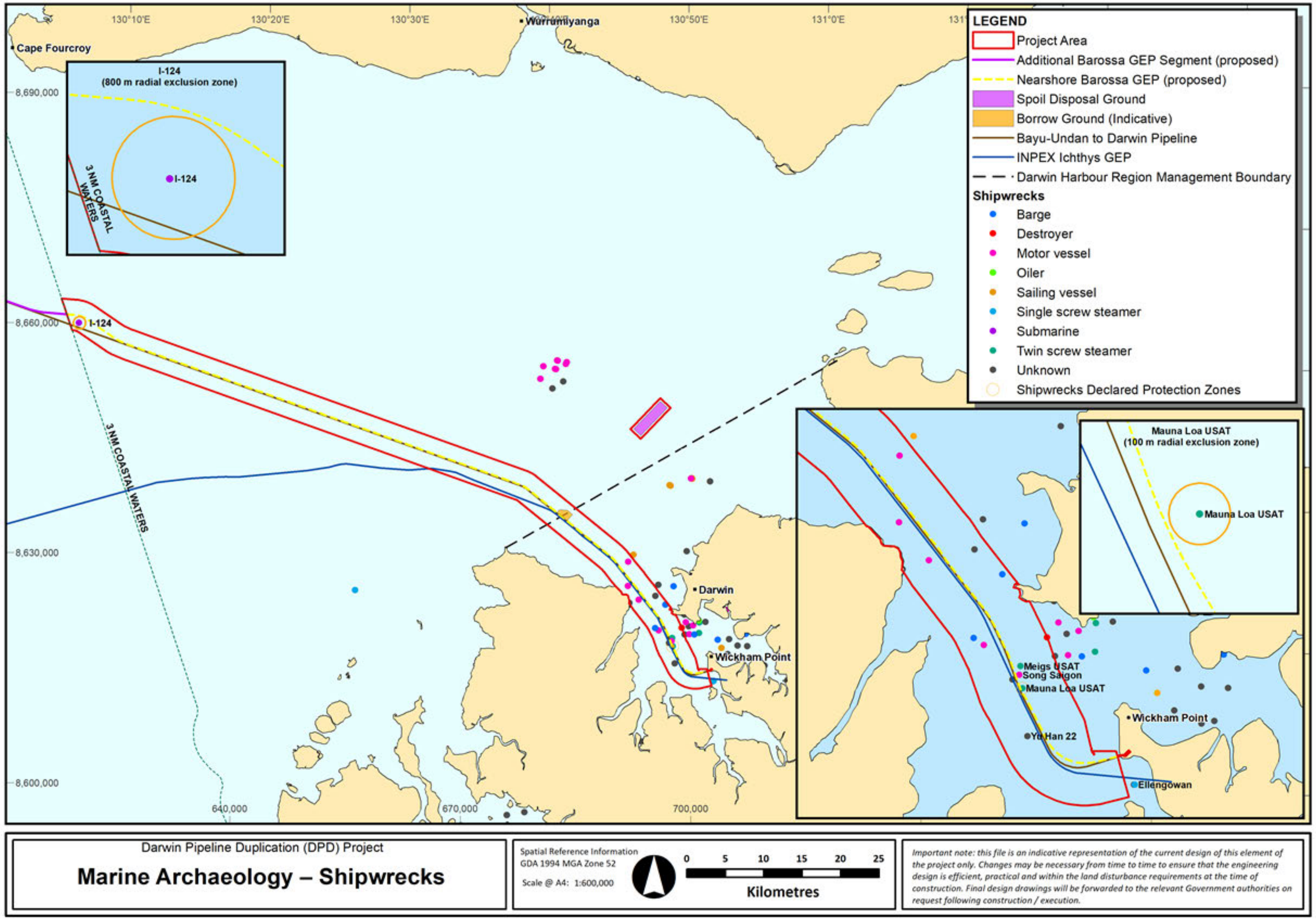


Figure 7-21 Marine archaeology – shipwrecks

[redacted]

[redacted]

8 Identification of Key Environmental Factors

Environmental factors are broad divisions of the environment that may be impacted by a project (NT EPA, 2021bc). The EPA has 14 environmental factors, organised into five themes: Sea, Land, Water, Air and People. The environmental factors and their corresponding objectives are summarised in **Table 8-1**.

The NT EPA has developed a screening tool to assist proponents in determining whether a project requires formal referral (NTEPA, 2021a). An initial screening exercise was undertaken for this Project utilising this screening tool, to determine the potential impacts to NT EPA factors associated with the Project. The screening assessment is provided in **Appendix F** with a summary provided in **Table 8-1**.

Based on the assessment for potential impacts, four of the EPA factors, Landforms, Hydrological Processes, Inland Environmental Quality, Aquatic Ecosystems and Human Health were determined to be not applicable (N/A) to the Project and therefore these factors have not been taken forward in this referral.

The following environmental factors were determined in the screening assessment as unlikely to result in significant impacts, however potential impacts may occur, and these factors have therefore been addressed in summary within **Appendix G**:

+ Terrestrial Environmental Quality;
+ Terrestrial Ecosystems;
+ Air Quality;
+ Atmospheric Processes;
+ Community and Economy; and
+ Cultural Heritage.

The following environmental factors have been assessed in detail in this referral (utilising the approach defined in **Section 9**), as they are considered key environmental factors with the potential for significant impacts:

+ Coastal Processes;
+ Marine Environmental Quality; and
+ Marine Ecosystems.

Table 8-1 NT EPA environmental factors and screening of significance

NT EPA Themes	NT EPA Factors and Objectives	Potential for significant impact	Description
Land	**Landforms** Objective: Conserve the variety and integrity of distinctive physical landforms so that environmental values are protected.	N/A	There will be no modifications to distinctive physical landforms, given the Project Area is in the marine environment or within the existing DLNG facility disturbance envelope. Therefore, this EPA factor is not considered relevant and has not been considered further in this referral.
	Terrestrial Environmental Quality Objective: Protect the quality and integrity of land and soils so that environmental values are supported and maintained	N	Construction activities will only disturb lands and soils within the existing DLNG facility disturbance envelope. Shoreline and onshore trenching has the potential to disturb relatively small volumes of acid sulphate soils (ASS). Detailed ASS investigations will be conducted to inform the development of an ASS Management Plan (ASSMP), and given similar management experiences with DLNG construction the issue will be readily manageable. Therefore, this EPA factor is not considered to be a key factor and further assessment is summarised in **Appendix G**.
	Terrestrial Ecosystems Objective: Protect the NT's flora and fauna so that environmental values including biological diversity, ecological integrity ecological functioning.	N	Construction activities will occur within cleared and disturb lands within the existing DLNG facility disturbance envelope. A recent, targeted vegetation survey confirmed that vegetation within the Project Area is highly disturbed and of low environmental value. Given the highly disturbed nature of the onshore Project Area, native fauna of conservation significance are unlikely to depend on the habitat or be present in significant numbers. Therefore, this EPA factor is not considered to be a key factor and further assessment is summarised in **Appendix G**.

Water	**Hydrological Processes** Objective: Protect the hydrological regimes of groundwater and surface water so that environmental values including ecological health, land uses and the welfare and amenity of people are maintained	N/A	There will be no modifications to natural hydrological processes, given the Project Area is in the marine environment or within the existing DLNG facility disturbance envelope. A construction-related surface water drainage system will be required during the wet season, and chemical storage areas / equipment (i.e. self-bunded generators) will be used to minimise spills and groundwater contamination risks. These are standard construction practices that are temporary. Therefore, this EPA factor is not considered relevant and has not been considered further in this referral.
	Inland Water Environmental Quality Objective: Protect the quality of groundwater and surface water so that environmental values including ecological health, land uses and the welfare and amenity of people are maintained.	N/A	There will be no impact to inland water environmental quality, given the Project Area is in the marine environment or within the existing DLNG facility disturbance envelope. Therefore, this EPA factor is not considered relevant and has not been considered further in this referral.
	Aquatic Ecosystems Objective: Protect aquatic habitats to maintain environmental values including biodiversity, ecological integrity and ecological functioning.	N/A	There are no freshwater aquatic ecosystems (i.e. lakes, rivers) located within or near the Project Area. Therefore, this EPA factor is not considered relevant and has not been considered further in this referral.
Sea	**Coastal Processes** Objective: Protect the geophysical and hydrological processes that shape coastal morphology so that the environmental values of the coast are maintained.	Y	To demonstrate that this EPA factor objective will be met, a detailed environmental assessment is provided in **Section 9.4.**

	Marine Environmental Quality Objective: Protect the quality and productivity of water, sediment and biota so that environmental values are maintained	Y	To demonstrate that this EPA factor objective will be met, a detailed environmental assessment is provided in **Section 9.5**.
	Marine Ecosystems Objective: Protect marine habitats to maintain environmental values including biodiversity, ecological integrity and ecological functioning.	Y	To demonstrate that this EPA factor objective will be met, a detailed environmental assessment is provided in **Section 9.6**.
Air	**Air Quality** Objective: Protect air quality and minimise emissions and their impact so that environmental values are maintained.	N	Construction activities within the existing DLNG facility disturbance envelop will be short-term and relatively small scale, with no nearby residential or sensitive receptors. Construction air emissions such as dust and equipment/vehicle exhaust are not predicted to be significant and are readily manageable. Dust will be generated during onshore stockpiling and marine loadout of rock for placement on the pipeline. For this referral it is assumed that these operations will take place at an existing dedicated third-party commercial facility within Darwin Harbour, and that standard dust control management measures will be implemented by the third party. Air emissions within Darwin Harbour and Offshore NT waters will be caused predominately by vessels, more specifically from engine exhausts. Such emissions will be managed in accordance with standard maritime requirements (e.g. MARPOL air pollution prevention certification) and not inconsistent with the large number of other commercial vessels transiting and operating within the Darwin Harbour. Therefore, this EPA factor is not considered to be a key factor and further assessment is summarised in **Appendix G**.

	Atmospheric Processes Objective: Minimise greenhouse gas emissions so as to contribute to the NT Government's aspirational target of achieving net zero greenhouse gas emissions by 2050.	N	Construction-related greenhouse gas (GHG) emissions will be predominantly associated with vessel, vehicle, equipment and helicopter hydrocarbon (e.g., diesel) combustion. Such emissions will be temporary and relatively short in duration (i.e. ~15 months). Santos and its contractors will continue to operate in accordance with respective climate change / carbon reduction polices and strategies in order to meet company emission reduction targets. This referral is based on the premise that the Project operations phase will not alter GHG emissions beyond those already approved. The DPD Project will convey natural gas from Barossa to DLNG facility. The DLNG environmental approvals described in **Appendix B** provide for this supply of natural gas and extended DLNG operations to approximately 2050. The extended DLNG operations will be managed in accordance with the Australian Government Safeguard Mechanism, which places a cap (baseline) on DLNG facility GHG emissions. Given GHG emissions will be regulated as part of the DLNG facility, they are not considered to be a key factor for this referral. Additional information is provided in **Appendix G**.
People	**Community and Economy** Objective: Enhance communities and the economy for the welfare, amenity and benefit of current and future generations of Territorians.	N	Construction activities will be largely associated with areas zoned for industrial and port operations. However, there is the potential for impacts to other marine users and members of the public. Such impacts may include, but are not limited to, a temporary reduction in water quality through increased sedimentation, project vessel interaction with commercial and recreational fishers, and an increase in local traffic, including heavy haulage vehicles. However, it is considered that such impacts will be temporary (i.e. 15 months) and localised and will not significantly impact on the local community and economy. As a benefit, the Project will provide employment and service and good supply opportunities for local people and businesses. The extended

			operation of the DLNG facility will ensure current economic benefits and revenue streams into the NT and Australian economies continue. Therefore, this EPA factor is not considered to be a key factor and further assessment is summarised in **Appendix G.**
	Culture and Heritage Objective: Protect sacred sites, culture and heritage.	N	Construction activities will occur within an existing pipeline corridor, adjacent to an existing offshore spoil ground and within the DLNG facility disturbance envelope. The pipeline route has been designed and construction activities (i.e. vessel anchoring) will be managed to avoid identified shipwrecks. No aboriginal sacred sites will be impacted, which will be certified by relevant government agencies (i.e. AAPA). Santos will continue to consult with relevant government authorities and traditional owners on cultural and heritage-related issues as required. Therefore, this EPA factor is not considered to be a key factor and further assessment is summarised in **Appendix G.**
	Human Health Objective: Protect the health of the Northern Territory population.	N/A	As construction activities will be largely associated with areas zoned for industrial and port operations, adverse impacts to human health within the NT are considered unlikely. Therefore, this EPA factor is not considered relevant and has not been considered further in this referral.

9 Environmental Impact Assessment Approach

9.1 Overview

This section describes the approach taken to assess the potential environmental impacts for the key EPA factors identified in **Section 8**. Broadly, the approach involves the identification of key Project activities that could impact the environment, consideration of suitable mitigation and management measures, and environmental assessment to demonstrate impact levels will be acceptable and as low as reasonably practicable.

More specifically, the approach includes the following steps:

+ Reviewing planned activities to determine which activities have the potential to significantly impact the values and sensitivities of the three EPA factors, as shown in **Table 9-1**;
+ Determining the planned and unplanned aspects associated with Project activities, and identifying which have the potential to interact with the values and sensitivities for each of the three key EPA factors, and which have the potential to result in significant impacts, as shown in **Table 9-2**;
+ Assessing the potential impacts to the values and sensitivities of the three key EPA factors from Project planned and unplanned aspects;
+ Identifying if additional information, work and/ or studies are required to reduce impact assessment uncertainty and/or to inform future management of Project activities;
+ Identifying suitable mitigation and management measures to reduce potential impacts to an acceptable level; and
+ Determining the level of residual risk for each of the three key EPA factors, by utilising the AS/NZS 4360:2004 (Risk Management)-aligned environmental risk framework proposed in **Appendix I**. This framework requires the consideration of additional management measures at certain risk levels to ensure impacts are as low as reasonably practicable.

Table 9-1 presents the review of Project activities, as relevant to each phase, that have potential for significant impact on the three key factors. **Table 9-2** presents the assessment of planned and unplanned aspects associated with Project activities that have the potential to interact with, or to significantly impact the values and sensitivities of the three key factors.

Sections 9.4 to **Section 9.6** present the potential impacts, mitigation and managements measures and level of residual risk for each of the three key environmental factors for Project activities identified as having potential for significant impact.

9.2 Impact assessment context

When evaluating the potential Project impacts, consideration was given to the extensive studies and monitoring conducted for similar projects in Darwin Harbour. These include the original Bayu-Undan to Darwin pipeline and DLNG Facility, and the more recent INPEX Ichthys project. In particular, the INPEX Ichthys project has been utilised as a proxy to assess impacts on the basis that it undertook similar work activities within a similar area (including spoil disposal) but on a greater spatial and temporal extent.

INPEX's Ichthys nearshore environmental monitoring program was extensive and continues to be undertaken as part of the NT Government Darwin Harbour Integrated Marine Monitoring and Research Program (IMMRP). The monitoring data provide valuable insight into 'if' and 'how' observations in the natural environmental variability within Darwin Harbour changed as a result of its activities.

The key findings from the Ichthys monitoring program (as reported by INPEX Browse, Ltd, 2014) were:

+ Upon completion of dredging activities, the turbidity concentrations at the monitoring sites closest to the dredging (i.e. Northeast Wickham Point and South Shell Island) had returned to natural conditions within a single spring-neap cycle following the completion of dredging;
+ No detectable dredging-related impacts to corals were observed at monitoring sites outside of East Arm;
+ No dredging-related impacts to seagrass habitats were observed and turbidity measured at seagrass monitoring sites were within the general range of natural variation;
+ Measurements of sedimentation levels in mangrove assemblages were below the level considered to potentially impact mangrove health;
+ No evidence of dredging-related impacts to fish health and catches;
+ No noticeable changes to the distribution of turtles and dugongs within Darwin Harbour that would indicate a potential influence of dredging; and
+ As predicted, dredging-related impacts to both infauna and epifauna were observed within the offshore spoil disposal ground following season one dredging, likely due to placement of dredge material on the seabed.

However, it must be remembered that the Ichthys monitoring program in NT waters was to monitor and evaluate potential impacts from a scope of activities that was significantly larger than proposed for this Project. The Ichthys project was authorised to dredge and dispose of 16.1 Mm3 of material to dredge a safe shipping channel and berthing area in East Arm which included dredging through the very hard substrate at Walker Shoal (INPEX Browse, Ltd, 2014).

In relation to material to be trenched for installing the Ichthys pipeline, an additional 0.466 Mm3 of material was authorised to be trenched to 'seat' the Darwin Harbour section of the pipeline which runs just south of the existing Bayu-Undan to Darwin pipeline and which had a much longer shore crossing (INPEX Browse, Ltd 2014). Spoil from the Ichthys project, both dredging and trenching, was placed in an offshore spoil disposal ground in the Beagle Gulf.

In comparison, a maximum volume of 0.75 Mm3 (with an expected volume of 0.20 Mm3) will be trenched to install the Project pipeline along the northern route, with the trenched material to also be disposed of at an offshore spoil disposal ground in the Beagle Gulf (adjacent to Ichthys spoil disposal ground).

Based on these monitoring observations for the significantly larger program of works, it would seem unlikely that with an appropriate management and monitoring framework that there is the potential for impacts from this Project to be any greater than those observed during Ichthys.

9.3 Decommissioning management

As described in **Section 3.5.4**, the Project pipeline and associated facilities will be decommissioned in accordance with regulatory requirements at that time.

The DLNG facility and existing Bayu-Undan to Darwin pipeline have existing conditions of approval for a future decommissioning plan and it is expected that the Project will be considered within this plan and/or a separate Project decommissioning plan (prepared notionally two years before end-of-life).

The process to develop a future decommissioning plan will include detailed options analysis, environmental impact and risk assessment, mitigation and management evaluation, and stakeholder consultation. The potential impacts and risks to values and sensitives of the EPA factors from potential decommissioning options (i.e. full to partial removal, leave in situ, re-purpose, etc.) could be similar in type, magnitude and extent to those presented in this referral. Consequently, no further environmental assessment from decommissioning is presented at this point in time.

Table 9-1 Summary of Project activities where there is potential for significant impact to values and sensitivities of the key factors

Sea factors and their indicative environmental values and sensitivities	Construction			Operations, including Inspection, maintenance and repair	Support Activities		
	Surveys	Pre-lay works	Pipeline installation and pre-commissioning		Vessel operations	Helicopter operations	ROV/AUV operations
Coastal processes							
Geophysical and hydrological processes							
Primary productivity, nutrient cycling, carbon storage, or climate regulation							
Conservation significant areas, storm surge protection, unique, or coastal landforms							
Cultural, aesthetic or recreation values							
Marine environmental quality							
Water quality							
Sediment quality							
Infauna, epifauna and biota quality							
Ecosystem health							

Physical parameters that support fishing, aquaculture recreation and aesthetics							
Industrial water supply							
Marine ecosystem							
Cultural and spiritual values							
Conservation significant marine areas							
Intertidal and benthic habitats							
Marine mammals							
Marine reptiles							
Pelagic and Demersal Fish Communities (including rays and sharks)							
Plankton							
Seabirds and migratory shorebirds							
Ecological function and processes							
Integrity of marine ecosystems, including biological and functional diversity							

	Potential for significant impacts (without mitigation and controls)
	No interaction between receptor and activity, or unlikely to result in significant impacts

Table 9-2 Summary of planned and unplanned aspects associated with Project activities that have potential to interact with, or to significantly impact values and sensitivities of the key factors

Sea factors and their indicative environmental values and sensitivities	Planned						Unplanned							
	Physical presence	Seabed disturbance	Noise emissions	Light emissions	Vessel utility discharges	Contingency discharges, i.e., from. wet buckle	Dropped objects	Loss of hazardous and non hazardous waste	Invasive Marine species	Marine fauna interaction	Non hydrocarbon and chemical release	Marine diesel release from bunkering incident	Marine diesel release from vessel collision	Dry gas release from pipeline rupture during operations
Coastal processes														
Geophysical and hydrological processes														
Primary productivity, nutrient cycling, carbon storage, or climate regulation														
Conservation significant areas, storm surge protection, unique, or coastal landforms														
Cultural, aesthetic or recreation values														
Marine environmental quality														
Water quality														

Sediment quality														
Infauna, epifauna and biota quality														
Ecosystem health														
Physical parameters that support fishing, aquaculture, recreation and aesthetics														
Industrial water supply														
Cultural and spiritual values														
Marine ecosystem														
Conservation significant marine areas														
Intertidal and benthic habitats														
Marine mammals														
Marine reptiles														
Pelagic and Demersal Fish Communities (including rays and sharks)														
Plankton														
Seabirds and migratory shorebirds														
Ecological function and processes, and integrity of marine ecosystems														

	Interaction possible but significant impact not expected
	Potential for significant impacts (without mitigation and controls)
	Interaction not reasonably expected

9.4 Coastal processes

9.4.1 Objectives, policies and guidance

Objective*: Protect the geophysical and hydrological processes that shape coastal morphology so that the environmental values of the coast are maintained.*

Relevant policy and guidelines include:

+ NT EPA Environmental Factors and objectives: Environmental impact assessment general technical guidance (NT EPA 2021c);
+ Anthropogenic Pressures on Darwin Harbour: An IMMRP Monitoring Plan (Version 1). Technical Report No. 11/2020 (Radke and Fortune 2020);
+ Guidelines for the environmental assessment of marine dredging in the Northern Territory (NT EPA 2013);
+ Darwin Harbour Strategy (DHAC 2020); and
+ Darwin Harbour Water Quality Protection Plan (DLRM 2014).

9.4.2 Potential significant impacts

Project activities

As presented in **Table 9-1**, the following Project activities have the potential to significantly impact geophysical and hydrological processes:

+ Construction
+ Pre-lay works:
+ Pre-lay works (includes trenching);
+ Spoil disposal outside of Darwin Harbour;
+ Pre-lay span rectification and foundation installation;
+ Shoreline construction; and
+ Pipeline installation activities, including post-lay span rectification, trenching and backfill, e.g., rock placement or engineered backfill from the borrow ground outside Darwin Harbour.

Planned and unplanned aspects of Project activities

Of the different planned aspects associated with Project activities, only seabed disturbance has the potential for a significant impact to coastal processes; in particular, geophysical and hydrological processes (refer **Table 9-2**). During operations, the physical presence of the pipeline (including stabilisation and protection measures) will alter the geophysical and hydrological processes, however, it is not expected to result in a significant impact.

No unplanned aspects are expected to significantly impact coastal processes (**Table 9-2**).

An assessment of whether seabed disturbance could result in a significant impact to coastal processes during construction and operations is presented below.

Key information used, and assumptions made in assessing potential impacts on coastal processes were:

+ Project geophysical surveys have not identify any seabed structures that requires extensive construction intervention in the coastal zone; and
+ Environmental monitoring data and information collected and reported as part of the INPEX Browse, Ltd monitoring programs (summarised in INPEX Browse, Ltd 2014) present a conservative assessment of the potential impacts from the Project given the significantly lower disturbance footprint (including scale, spatial extent and duration).

9.4.2.1 Geophysical and hydrological processes

The Project pipeline through Darwin Harbour is aligned with existing pipeline corridors and the shore crossing and onshore areas have previously been disturbed during the installation of the Bayu-Undan to Darwin pipeline. A rock groyne from the original DLNG facility construction remains within the intertidal zone. There are no conservation significant areas, unique or coastal landforms in the Project Area.

Construction

<u>Seabed disturbance</u>

Seabed disturbance will occur as a result of trenching, spoil disposal, removal and subsequent re-use of seabed from the borrow ground (e.g., engineered backfill), and rock placement. Digging the trench for the shore crossing will also modify the current shoreline. While direct changes to the seabed along the Project pipeline, spoil disposal ground and borrow ground will remain while the infrastructure is in place, these activities are not expected to change the underlying hydrodynamics of the environment given the scale and nature of seabed disturbance, proximity to existing infrastructure/pipelines and the underlying physical forces that operate in Darwin Harbour. INPEX Browse, Ltd (2010a) undertook hydrodynamic modelling to investigate the potential changes to local hydrodynamic processes from activities associated with installing the pipeline and dredging the channel turning basin, approach area, and berthing area in East Arm (none of which are proposed for the Project). That modelling study concluded overall effects on the hydrodynamics of the area would be minor and not cause any significant change to inundation of intertidal mangrove areas, or natural sedimentation and erosion patterns. As this Project has a significantly smaller scope of activities and disturbance footprint compared to the full Ichthys programme, it is unlikely that there would be any long-term changes to the geophysical and hydrological processes, or the wider coastal processes of the area.

For the shore crossing activities, required shoreline modifications and onshore construction would only be temporary and localised to a previously disturbed shore crossing location. Construction of a rock groyne would build on and extend the existing rock groyne in the intertidal area which was constructed as part of the original DLNG facility construction. The new rock groyne construction would be temporary for the shore crossing and allow land-based trenching to extend further into the harbour instead of needing the anchored pipelay vessel to come closer into shore. No change in coastal processes have been observed as a result of the original existing rock groyne and thus any shoreline modifications would only result in temporary changes to geophysical and hydrological process as the site would be remediated to a condition similar to what it was in prior to construction. Consequently, it is unlikely that construction could have a significant impact to any values or sensitivities associated with the coastal processes.

Operations

Seabed disturbance

Due to the size and the low profile of the Project pipeline (including any backfill or stabilisation measures installed) and the underlying hydrodynamics within Darwin Harbour, it is unlikely that the presence of the pipeline during operations could have a significant impact to any values or sensitivities associated with the coastal processes factor. In support of this conclusion, there is no evidence that the existing Bayu Undan to Darwin pipeline (26 inch) or Ichthys (42 inch) have significantly impacted coastal processes.

If required, pipeline maintenance and repair work (i.e. freespan rectification and in a worst-case scenario, replacing sections of pipe) will disturb the seabed, but given the focussed spatial and temporal extent of any repair activity, it is unlikely to have a significant impact to any coastal processes.

As for the construction phase, it is unlikely that Project operations could significantly impact coastal processes.

9.4.3 Potential cumulative impacts

Given the proposed location, the narrow linear pipeline corridor (i.e., notional 50-m pipeline disturbance footprint), proximity of the spoil ground to an existing and much larger spoil ground and based on knowledge gained from planning and executing similar pipeline projects in this location, potential impacts to geophysical and hydrological processes that may occur will be localised and small in nature. As a result, it is unlikely that these impacts could accumulate to result in a significant impact to coastal processes in the Darwin Harbour and associated offshore waters.

Should other proponents be considering similar activities over similar locations and time frames to Project activities, Santos will work with other proponents to consider the potential for cumulative impacts and mitigate where reasonably practicable.

9.4.4 Environmental mitigation and management

The following measures will be implemented to mitigate and manage the potential environmental impacts from the Project. A number of these mitigation measures are already implemented for the existing DLNG facility operations, as per the DLNG OEMP (DLNG/HSE/PLN/001) which Santos has been operating since 2006. Consequently, there is demonstrated experience mitigating and managing environmental impacts and risks from Project activities.

Avoid

+ Given the need for a shore crossing and intervention works to stabilise and protect the Project pipeline, some impact to the coastal zone, no matter how temporary or localised, are unavoidable.

Mitigate

+ Pre-lay survey will be completed to ensure the Project pipeline route is optimised and avoids hard, protruding seabed features if identified and where safe to do so; and
+ Removal of the Project’s temporary groyne shortly after the pipeline has been successfully commissioned and is operational.

Manage

- A Construction Environmental Management Plan (CEMP) will be developed to detail how construction will be undertaken and controlled; and
- A Trenching, Spoil Disposal Management and Monitoring Plan (TSDMMP) will be developed to include controls for trenching activities and detail an environmental (marine) monitoring program.

9.4.5 Conclusion of residual risk

Following the implementation of the mitigation and management measures above and considering the nature of the receiving environment (e.g., pipeline duplication within a disturbed pipeline corridor and industrial precinct), the environmental consequence to coastal processes is considered to be 'Negligible' and residual risks 'Low' (refer to **Appendix I** for Environmental Risk Framework).

9.4.6 Predicted outcome and conclusions

The Project is not inconsistent with the above listed government policies and guidelines, and no stakeholders have raised objections or concerns about coastal process impacts.

Considering the environmental assessment as supported by publicly available and extensive monitoring data, and with the application of management and monitoring commitments, it is concluded that environmental impacts and risks to coastal processes are acceptable and manageable, and that the NT EPA objective for this factor will be met.

9.5 Marine environmental quality

9.5.1 Objectives, policies and guidance

Objective: *Protect the quality and productivity of water, sediment and biota so that environmental values are maintained.*

Relevant policy and guidelines include:

- NT EPA Environmental Factors and objectives: Environmental impact assessment general technical guidance (NT EPA, 2021c);
- Anthropogenic Pressures on Darwin Harbour: An IMMRP Monitoring Plan (Version 1). Technical Report No. 11/2020 (Radke and Fortune, 2020);
- Guidelines for the environmental assessment of marine dredging in the Northern Territory (NT EPA, 2013);
- Darwin Harbour Strategy (DHAC, 2020); and
- Darwin Harbour Water Quality Protection Plan (DLRM, 2014).

9.5.2 Potential significant impacts

Project activities

As presented in **Table 9-1** above, the following Project activities have the potential to significant impact on marine environmental quality:

- Construction
  - Pre-lay works:

    - Pre-lay works (includes trenching);
    - Spoil disposal outside of Darwin Harbour;
    - Pre-lay span rectification and foundation installation;
    - Onshore construction;
  - Pipeline installation activities, including post-lay span rectification, trenching and backfill, e.g., rock placement or engineered backfill from the borrow ground outside Darwin Harbour; and
- Operations (i.e. maintenance and repair).

Support activities including vessel and ROV/AUV operations to be undertaken during construction and operations phases are routine activities and can be controlled and managed using standard operating practices and compliance with legislation, e.g., Protection of the Sea (Prevention of Pollution from Ships) Act 1983 which gives effect to MARPOL in Australia. It is unlikely that these short-term and localised activities could result in significant impacts to marine environmental quality; hence, are not assessed in this referral.

Planned and unplanned aspects of Project activities

Of the different planned aspects associated with Project activities, seabed disturbance and the contingency discharge of treated seawater (in the event a prolonged wet buckle scenario occurs during construction) have the potential for a significant impact to marine environmental quality; in particular the following values and sensitivities (refer **Table 9-2**):

- Water quality; and
- Physical parameters that support fishing, aquaculture, recreation and aesthetics.

Of the unplanned aspects, there is the potential for significant impacts to the following values and sensitivities from an introduction of an invasive marine species, from a marine diesel release during bunkering or a vessel collision, or from a dry gas release from a pipeline rupture during operations (refer **Table 9-2**):

- Water quality;
- Ecosystem health; and
- Physical parameters that support fishing, aquaculture, recreation and aesthetics.

An assessment of the planned and unplanned aspects that could have a significant impact to marine environmental quality during construction and operations is presented below.

Key information used, and assumptions made in assessing potential impacts on marine environmental quality were:

- Information from the installation of the Bayu-Undan to Darwin pipeline did not identify difficulties in relation to ASS with samples taken at the same location finding the material to be self-neutralising and where ASS were identified, these were disposed of below water surface to prevent oxidation; and
- Environmental monitoring data and information collected and reported as part of the INPEX Browse, Ltd monitoring programs (summarised in INPEX Browse, Ltd 2014) present a

conservative assessment of the potential impacts from the Project given the significantly lower disturbance footprint (including scale, spatial extent and duration).

9.5.2.1 Water quality

Decreases in water quality can also both directly and indirectly impact the marine organisms in the water column and on the seabed (i.e. benthic habitats, invertebrates and primary producers). Impacts to these biotas are discussed further in the **Section 9.6** below.

Construction

Seabed disturbance

Activities that will disturb or interact with the seabed will cause sediment particles of different sizes to be suspended in the water column where they will remain for periods of time depending on the particle size. Larger particles will drop out quickly, while smaller particles will remain suspended for longer and can be carried from the disturbance site with tides and currents. Once settled to the seabed, smaller particles may become resuspended during any subsequent disturbances and/or from tidal and current flows. Sediments can become suspended as a result of mechanical action, e.g., during trenching activities to dig into the seabed, as a result of disposing of the trenched seabed material at the spoil disposal grounds, and from backfill activities where soil or rock is placed to protect the pipeline. The additional sediment load in the water column will result in temporary and localised decreases in water quality including increased turbidity due to suspended/resuspended sediments and associated decrease in light penetration. Depending on the scale of disturbance, this suspension of sediments can result in a visible sediment plume around the disturbance site.

Decrease in water quality will be greatest around the pipeline trenching and rock placement areas within the harbour and the spoil disposal ground and borrow ground during construction.

The likely spatial and temporal extent of suspended sediments and sedimentation will be defined using sediment dispersion modelling. This modelling will be prepared once data from the Project geophysical and geotechnical surveys are available and be used to inform the trenching monitoring as part of the TSDMMP (i.e., to identify monitoring sites). In the absence of this modelling, Santos has used the Ichthys EIS sediment modelling (INPEX Browse, Ltd, 2010a) and extensive monitoring program (as reported by INPEX Browse, Ltd, 2014; refer to **Section 9.2**) for this referral.

Naturally high variability in water turbidity was observed during the Ichthys baseline studies where outer sampling sites had much greater range in natural turbidity because of the different wind/wave and swell effects compared to Darwin Harbour (NPEX Browse, Ltd 2010a). The Ichthys data also highlighted the effects that natural forcing conditions, like tidal range, waves and monsoonal activity, have on turbidity.

Monitoring results from the Ichthys monitoring programme (INPEX Browse, Ltd 2014) recorded only relatively small increases (5 to 10 NTU) in the median of daily average turbidity during both its dredging periods compared to baseline data for sites ~1 km from the dredging in East Arm (Northeast Wickham Point and South Shell Island sites). Data from sites with coral habitats, e.g., at Weed Reef and Channel Island (~15 km from dredging), showed no change in water quality as a result of dredging activity with turbidity at these sites within the range of natural variability during both dredging periods.

Upon completion of dredging activities, the turbidity concentrations at the monitoring sites closest to the dredging (i.e., Northeast Wickham Point and South Shell Island) had returned to natural conditions within a single spring-neap cycle following the completion of dredging (INPEX Browse, Ltd 2014).

The observations from the Ichthys dredging program were made during a much larger work program that had authorisation to dredge up to 16.1 Mm3 of seabed (included dredging the channel, the turning basin, approach area and berthing area in East Arm) compared to the maximum trenching volume for this Project of 0.75 Mm3 (0.2 Mm3 expected volume). Given activities for this Project will be over a more restricted spatial and temporal extent and only related to works to stabilise and protect the Project pipeline, water quality changes from construction activities are likely to be significantly less than those recorded during the Ichthys program. Santos' proposed environmental monitoring for trenching as part of the TSDMMP will be used to validate this assessment.

Acid sulphate soils (ASS)

Water quality may also be impacted from acid sulphate soils (ASS) during shoreline construction activities. ASS are naturally occurring sediments and soils containing sulfides that when exposure to air and water can result in formation of sulfuric acid. This acid can subsequently cause naturally occurring heavy metals such as aluminium, manganese, copper and arsenic to leach from soils and sediments, resulting in secondary contamination of soils and water in nearby environments. In addition, the acidity can reduce the pH conditions of soil, sediments and water. The toxicity and potential for bioaccumulation of these metals, as well as the reduction of pH can have a range of impacts to both flora and fauna that live within them.

ASS are known to occur in sediments within the Darwin Harbour, intertidal and foreshore areas and are expected to be encountered during Project construction phase trenching. Given this knowledge, Santos will complete a detailed assessment of ASS and develop an ASS Management Plan.

The main management approach will be to keep the ASS or Potential Acid Sulphate Soils (PASS) material submerged, alongside the trench within the existing pipeline disturbance footprint or disposed of at the spoil disposal ground. If this is not possible, ASS/PASS will be removed and stored onshore and treated with lime or other approved neutralising chemicals. ASS/PASS material may be used as backfill after treatment onsite with lime. If it is not suitable for re-use, it will be removed for offsite disposal or disposed of at the spoil disposal ground. As the volume of trenched material that would be excavated and temporarily stockpiled onshore is relatively small (i.e. pipeline trench only hundreds of metres), ASS/PASS stockpiles will be readily manageable using standard industry practices.

Project ASS risks are well known and the range of practical management strategies that are available and will be implemented as required are effective. This was demonstrated by the Bayu-Undan to Darwin pipeline and Ichthys pipeline which were at a larger scale, including ~1 km of trenching through mangrove and salt flats for the Ichthys shore crossing as compared to ~100 m through a previously disturbed area for the Project. During the installation of the Bayu-Undan to Darwin pipeline, no difficulties in relation to ASS occurred and samples taken at that same location found the material to be self-neutralising and no lime dosing was required. Where ASS were identified, these were disposed of below water surface to prevent oxidation.

Contingency discharge of treated seawater following a wet buckle

The other planned aspect that has the potential to significantly impact water quality is if there is a need to discharge treated seawater in the event of a prolonged wet buckle scenario. As described in **Section 3.5.2.7**, if a wet buckle during pipeline installation occurs and there is going to be an extended period before pipelay can recommence (typically greater than 30 days), the pipeline will need to be filled (from the DLNG-end) with inhibited seawater to safely preserve the pipeline in the intervening period before pipelay is recommenced. If preservation is required, there is the potential for some of the inhibited seawater to be discharged as a result of over pump. As the inhibited seawater will be treated with chemicals, e.g., corrosion inhibitors, oxygen scavengers and biocides, discharge could result in a localised and temporary reduction in water quality. Chemicals that will be used are inherently biodegradable with low potential for bioaccumulation and given the relatively low volume (less than 600 m3) and the dynamic tides and currents inside and outside Darwin Harbour, it is expected that any discharge would dilute quickly from the point of discharge (ConocoPhillips, 2018a). For these reasons, no substantial change in water quality is expected and significant impact to the marine environmental quality is not expected.

<u>Unplanned marine diesel release</u>

Water quality may also be impacted from an unplanned marine diesel oil (MDO) release during bunkering or in the unlikely event of a significant vessel collision. During construction, multiple vessels will be operating and the risk assessment has been based on a worst case scenario for a vessel collision with the larger pipelay vessel leading to a marine diesel release. In considering guidance from AMSA on spill contingency planning for vessel-based activities (Australian Maritime Safety Authority, 2013a) and based on a review of fuel tank arrangements for all vessels that could be contracted, a maximum spill volume of 700 m^3 was deemed reasonable to inform the risk assessment.

The larger pipelay vessel will be laying in the offshore NT waters and while it may continue laying pipe into Darwin Harbour (subject to operations requirements), its pipelay ability will be limited by water depth required to operate on DP. For other vessels, including the smaller pipelay vessel that will be working from the shore pull out towards the mouth of Darwin Harbour, the potential spill release volumes would be lower as the smaller vessels would not have such large tanks. The credible spill volume for the smaller pipelay vessel and support vessels would be 350 m3.

Project vessels will be fuelled by marine diesel oil (MDO) or marine gas oil (MGO). Santos will not permit the use of heavier fuel types, such as intermediate fuel oil (IFO) or heavy fuel oil (HFO). MDO/MGO is a medium grade non-persistent fuel used in the maritime industry. In the event of an unplanned release to sea, approximately 60% to 80% of the MDO/MGO is predicted to evaporate within 24 to 48 hours, depending upon the prevailing conditions with greater evaporation occurring as a result of stronger winds.

The rapid evaporation is due to MDO/MGO being a mixture of volatile, semi-volatile and low volatility hydrocarbons. It has a low viscosity (4 cP), which indicates that this hydrocarbon will spread quickly if spilt at sea and will have a thin to low thickness level on the sea surface thereby increasing the rate of evaporation. The heavier components of MDO/MGO tend to become entrained into the upper water column as oil droplets in the presence of waves but can re-float to the surface if wave energies abate. Entrained MDO/MGO is largely concentrated in surface waters (0 to 10 m).

Table 9-3 Characteristics of marine fuel oil

Density at 25 °C (kg/m³)	Viscosity at 25 °C (cP)	Component Boiling Point (°C) % of Total			
		Volatile (%) <180	Semi-volatile (%) 180 to 265	Low Volatility (%) 265 to 380	Residual (%) >380
829	4.0	6	35	54	5

Based on these characteristics (refer to **Table 9-3**), if an MDO/MGO release occurred, the rapid weathering of released fuel oil would result in a short-term reduction in water quality in the upper surface waters of the water column.

In the event of an unplanned marine fuel oil spill to sea, Santos would implement its oil spill response plan (also referred to as Oil Pollution Emergency Plan). Project oil spill modelling will be completed to inform spill preparedness and response arrangements including the identification of protection priorities. However, given the rapid weathering characteristics of fuel oil, the primary spill response arrangement will be to monitor and evaluate. If required, Santos will be prepared to support the implementation of other spill response arrangements such as shoreline protection, shoreline clean-up and oiled wildlife response.

Collisions involving offshore support vessels, comparable to those that will undertake pipeline installation activities, are very uncommon and statistics compiled by the Australian Transport Safety Bureau (ATSB) indicated that offshore support vessels were involved in only one collision-related incident between 2011 and 2012, and no pollution-related incidents from offshore support vessels were recorded in the same time period. In addition, there are a range of controls based on Australian maritime requirements that will be implemented to reduce the potential for interactions with other marine users and reduce the likelihood of a collision.

Operations

<u>Seabed disturbance</u>

If pipeline maintenance and repair were required to the Project pipeline during operations, e.g., from typical freespan rectification through to having to repair/replace a section of pipe that could have been damaged, these activities will disturb the seabed and result in temporary and localised decreases in water quality. The likelihood of this occurring is low and potential impacts would be similar for other projects such as Bayu-Undan to Darwin pipeline and the Ichthys pipeline.

Compared to the construction phase, the spatial and temporal extent of any such maintenance and repair activities during operations would be significantly less due to them being related to a particular section rather than the entire pipeline. Therefore, potential impacts from operations activities would be far more localised and temporary compared to those presented above for the construction phase. As such, it is unlikely that planned operations aspects would have a significant impact on water quality.

<u>Unplanned marine diesel release</u>

As vessel-based activities are part of operations, the risk from an unplanned marine diesel release will remain during operations. As vessels supporting operations will be smaller support vessels compared to the large DP pipelay vessel, the worst-case credible spill scenario is considered to be no greater than 350 m^3. Consequently, and as described above, any impacts to water quality would be temporary.

9.5.2.2 Ecosystem health

Construction and operations

<u>Unplanned introduction of IMS</u>

The potential for a significant impact to ecosystem health comes for the potential introduction of an invasive marine species (IMS). The introduction of IMS may result in considerable modification of the environment through out-competing native species and modifying existing habitats. Such modifications may result in significant environmental impact, including decrease in biodiversity, reduction in coastal aesthetics and overall ecosystem health.

Vessels are the most common vector for the translocation of IMS in the marine environment. IMS can be introduced or spread when vessels are mobilised to the Project Area, particularly if the vessels originate from international waters with similar water temperatures (i.e., south-east Asia). IMS may be present as biofouling (i.e., adult sessile organisms) on vessel hulls and submersible equipment, and in the ballast water (i.e., as larvae).

For an IMS to establish, it must be present on a vector, e.g. biofouling or in ballast water on a project vessel, it must be released from the vector and then find suitable habitat to establish. Many potential IMS are sessile benthic organisms (e.g. mussels) and it is recognised that artificial, disturbed and/or polluted habitats in tropical regions are susceptible to invasive marine species introductions, which is why ports are often areas of higher IMS risk.

As illustrated in **Figure 7-16**, shipping traffic in the offshore NT waters of the Project Area is relatively light however, at the approach to Darwin Harbour, and within the harbour itself, several notable shipping traffic lanes converge to create a high-density shipping traffic area that overlaps with the Project Area. Hence, IMS risks are not unique to the Project and Project vessel numbers and movements will be insignificant compared to the total number of vessel movements within the Darwin Harbour (i.e. Port of Darwin recorded 2,154 vessel visits in 2018-19).

IMS risks are well known, and Santos applies both internal and legislated procedures to mitigate and manage the risk of introducing IMS to Australian waters across all its operations. Santos has successfully applied these measures to its numerous offshore operations and consider the risk of introducing IMS to be low.

9.5.2.3 Physical parameters that support fishing, aquaculture, recreation and aesthetics

Construction

<u>Seabed disturbance</u>

During trenching, spoil disposal and backfill activities, the increased turbidity and sediment levels in the water may result in a visible surface plume which is often associated with such activities. While such plumes may lead to a decline in aesthetics during these activities, they will be localised and temporary in nature.

During environmental monitoring for the Ichthys Development, INPEX Browse, Ltd (2014) used MODIS satellite imagery to monitor surface total suspended solids (TSS) plumes at a regional scale. The monitoring demonstrated that elevated turbidity attenuated to background levels within 5 km from the source at the spoil disposal ground (adjacent to the spoil disposal ground for this Project), and within ~ 8 km of the dredge source in East Arm with dispersion greater during spring tides (stronger currents) and during the dry season. It should be noted that the increased turbidity from dredging in the East Arm location was a result of dredging the channel through Walker Shoal which required significantly more dredging to be undertaken than the pipeline trenching required for this Project. Consequently, any decline in visual aesthetics due to surface sediment plumes would be significantly lower for the Project, and it is expected that surface TSS would return to background levels over a much shorter distance and time frame.

INPEX Browse, Ltd (2014) also undertook Access Point Surveys (APS) and interviewed recreational fishers to identify potential changes and general profiles of fishing effort in the harbour that may be attributed to the project. INPEX Browse, Ltd (2014) reported that slight but clear small-scale spatial shifts in fishing effort were recorded during dredging surveys, e.g., fishing around lower East Arm (near dredging) showed a 3% decline, but these were accompanied by slight increases in other areas around Darwin Harbour, e.g., further up East Arm, across to the western side of the harbour and open waters outside the harbour. INPEX Browse, Ltd suggested that dredging related factors such as navigational issues, restricted access to fishing spots due to exclusion zones and an unattractive environment for fishing were also likely to contributed to the small-scale spatial shift observed within Darwin Harbour. Despite this small shift, INPEX Browse, Ltd (2014) reported that catch rates in Darwin Harbour estimated from interviews and from independent standardised fishing monitoring, were generally similar throughout the monitoring program.

INPEX Browse, Ltd (2014) also monitored for any instances of ill health among fish and crabs (from samples collected) and characterised and monitored a range of naturally occurring parasites and diseases. The objective was to monitor spatial and temporal change in environmental conditions, immune suppression and stress which could result in decreased health (INPEX Browse, Ltd, 2014). The results did not provide any indication that dredging in the harbour changed instances of ill health or suppressed immunity in the fish and crabs examined. Interestingly, the study did identify seasonal variability in the prevalence of parasitic and bacterial infections across Darwin Harbour and reference locations, and reported it was most likely related to naturally driven changes in environmental conditions (INPEX Browse, Ltd, 2014).

Given the Ichthys project's dredging campaign was significantly larger than the trenching proposed for the Project, any impact to access and aesthetics of fishing and recreational areas would be much lower and consequently, are not expected to have significant impact on the physical parameters that support fishing, aquaculture recreation and aesthetics.

<u>Unplanned marine diesel release</u>

Unplanned release of marine diesel during bunkering or a vessel collision, while unlikely, are still credible scenarios. Consequently, both the decrease in water quality and the perceived aesthetics of an area that was impacted by a marine diesel release could result in an impact to the physical parameters that support fishing, aquaculture recreation and aesthetics.

As described above in the water quality impact assessment section, if an MDO release occurred, the rapid weathering of released MDO and the relatively small spill that may occur would mean that there would be localised reduction in water quality in the upper surface waters of the water column near the location of the spill, but it is expected that any impacts would be temporary and localised in nature and not have a significant impact on marine environmental quality. The perception on aesthetics to return to fish or undertake recreation activities in the area may persist a little longer, but a significant impact is not expected.

Potential impacts to marine fauna, including fish, and the wider marine ecosystem are presented in **Section 9.6**.

Operations

Seabed disturbance

Given the level of seabed disturbance that could occur during any maintenance and repair activities would be significantly less than during the construction phase, it is unlikely that operations activities would have a significant impact on the physical parameters that support fishing, aquaculture recreation and aesthetics.

Unplanned marine diesel release

As vessel-based activities are part of operations, the risk of an unplanned marine diesel release remains during operations. As vessels supporting operations will be smaller support vessels compared to the large DP pipelay vessel, the worst-case credible spill scenario is considered to be no greater than 350 m3. Consequently, and as described above, any impacts to water quality would be temporary.

Dry gas release from pipeline rupture during operations

During operations, the pipeline will transport dry gas (i.e., no liquid phase hydrocarbons) from the Barossa field to the DLNG facility. Therefore, no liquid phase hydrocarbons can be released to the environment in the event of a pipeline loss of containment. Given the pressure and temperature differential between the contents of the pipeline and the receiving environment, condensation of gas phase components of the dry gas will not occur upon release.

Valves to isolate the pipeline will be located on the Barossa FPSO and the DLNG facility; there are no other points at which the contents of the pipeline can be isolated.

A pipeline rupture during operations would result in a release of dry gas to the environment and could be caused by the following events:

+ Over pressurisation;
+ Excessive free spans resulting in movement, overstressing or fatigue;
+ Local overstress due to pressure and thermal expansion;
+ Materials or weld failure;
+ Early consumption of sacrificial anodes;
+ Internal corrosion in Pipeline;
+ External corrosion on Pipeline;
+ Blockage of Pipeline (e.g., closed valve or stuck pig);
+ Cyclone or seismic activity;

+ Damage to Pipeline due to military exercises in the Military Exercise Zone; or
+ Damage to Pipeline to anchor impact/drag or trawl boards associated with commercial fishing activities.

The scale of a pipeline leak is dependent on the nature of the rupture. Small 'pinhole' leaks will result in a stream of bubbles which may dissolve before reaching the surface. A major rupture (e.g., catastrophic failure) would result in the discharge of a dry gas forming a large plume in the water column and dispersing into the atmosphere.

In the event of a full rupture, a gas plume would be released from the pipeline and move towards the surface, with some of the gas becoming dissolved in seawater as the plume rises. A worst-case pipeline rupture would lead to the formation of a large gas cloud, which would rapidly disperse in the atmosphere. Methane (the main component of the dry gas) is lighter than air and would rise into the atmosphere, away from the release location.

Given the dispersion of gas into the atmosphere, this potential effect would be highly localised to the release location.

A leak from the Pipeline in Darwin Harbour has the potential to cause significant disruption to other users, however a rupture outside of Darwin Harbour is less likely to impact other users due to comparatively low use levels. In a worst-case scenario, the gas cloud could pose a significant risk to the health and safety of other users, such as fishers (traditional and commercial), tourism and recreational users, and (in the event of a release in Darwin Harbour) other port users. A gas cloud could potentially form an explosive mix which, if ignited, result in injury / death and damage to property.

Recognising the risk, the pipeline route and construction and installation design mitigates risk; for example, the pipeline is aligned with existing pipelines that have been operating since 2006 without incident and sections of the pipeline within Darwin Harbour will be trenched and protected by rock backfill to reduce the likelihood of damage to the pipeline.

The pipeline will be operated and maintained within its design envelope (based on design specification and international standards), and as described in the (to be developed) Safety Case, as Santos has been doing since 2006 for the Bayu-Undan to Darwin pipeline. An ongoing IMR programme will be implemented which is a proven and effective control to maintain the integrity of the pipeline based on the Bayu-Undan to Darwin pipeline operations history. An emergency response procedure will also be prepared to minimise potential impacts to other users and the environment in the event of a pipeline rupture.

Based on this and that the risk is no different to the risk from other operating pipelines in the area, the risk of a dry gas release from a pipeline rupture during operations causing significant impacts to marine environmental quality is considered to be low.

9.5.3 Potential cumulative impacts

Given the proposed location, the narrow linear pipeline corridor (i.e., notional 50 m pipeline disturbance footprint within an existing pipeline corridor), proximity of the spoil disposal ground to an existing and much larger spoil ground and based on knowledge gained from planning and executing similar pipeline projects in this location, potential impacts to quality and productivity of water, sediment and biota that may occur will be localised and temporary in nature. As a result, it is unlikely that these impacts could accumulate to result in a significant impact to marine environmental quality in the Darwin Harbour and associated offshore waters.

Should other proponents be considering similar activities over similar locations and time frames to Project activities, Santos will work with other proponents to consider the potential for cumulative impacts and mitigate where reasonably practicable.

9.5.4 Environmental mitigation and management

The following measures will be implemented to mitigate and manage the potential environmental impacts. A number of these mitigation measures are already implemented for the existing DLNG facility operations, as per the DLNG OEMP (DLNG/HSE/PLN/001) which Santos has been operating since 2006. Consequently, there is demonstrated experience mitigating and managing environmental impacts and risks from Project activities.

Additional details on forward management commitments are provided in **Section 12.1**.

Avoid

+ Given the seabed characteristics and need for intervention to install, stabilise and protect the Project pipeline, some impacts to marine environmental quality, no matter how temporary or localised, are unavoidable; and
+ Only marine diesel oil (MDO) or marine gas oil (MGO) will be used, thereby avoiding the risk of more environmentally persistent heavier fuel types, such as intermediate fuel oil (IFO) or heavy fuel oil (HFO), from being released to the marine environment.

Mitigate

+ Pre-lay survey will be completed to ensure the Project pipeline route is optimised and avoids hard, protruding seabed features if identified and where safe to do so; and
+ Chemicals used for treated seawater will be selected in accordance with Santos chemical selection procedures to ensure only environmentally acceptable chemicals are used;

Management

+ A Construction Environmental Management Plan (CEMP) will be developed to detail how construction will be undertaken and controlled;
+ A Trenching, Spoil Disposal Management and Monitoring Plan (TSDMMP) will be developed to include controls for trenching activities and detail an environmental (marine) monitoring program;
+ An Acid Sulphate Soils Management Plan (ASSMP) will be developed to manage shore crossing trenching where ASS/PASS maybe excavated and require storage, treatment and disposal;
+ An OEMP will be developed and will identify ongoing environmental management measures and oil spill response measures in the event of a hydrocarbon spill from a vessel or the pipeline. The primary spill response will be to monitor and evaluate, given the rapid weathering characteristics of MDO and MGO used in vessel operations and with the pipeline transporting dry gas only. Santos will be prepared to implement other spill response arrangements such as shoreline protection, shoreline clean-up and oiled wildlife response in the unlikely event this was required; and

+ Santos will continue to implement its Stakeholder Engagement Plan to ensure that relevant stakeholders and members of the community remain informed about Project activities including the potential for temporary impacts to commercial and recreational fishing.

9.5.5 Conclusion of residual risk

Following the implementation of the mitigation and management measures above and considering the nature of the receiving environment (e.g., pipeline duplication within a disturbed pipeline corridor and industrial precinct; with a spoil ground adjacent to an existing facility; vessels operating in a major Northern Australian port), the environmental consequence to Marine Environmental Quality is considered to be 'Minor' and residual risks 'Low' (refer to **Appendix I** for Environmental Risk Framework).

9.5.6 Predicted outcome and conclusions

The Project is not inconsistent with the above listed government policies and guidelines.

Stakeholders have raised concerns regarding potential water quality impacts from trenching-related activities, as well as impacts to other marine and harbour users. Santos acknowledges these issues and is committed to ongoing and transparent communication with identified stakeholders and members of the Darwin community. To this end, Santos will continue to implement and update a Project SEP (**Appendix C**) and make its environmental management plans and monitoring programs publicly available.

Considering the environmental assessment as supported by publicly available and extensive monitoring data, and with the application of management and monitoring commits, it is concluded that environmental impacts and risks to marine environmental quality are acceptable and manageable, and that the NT EPA objective for this factor will be met.

9.6 Marine ecosystems

9.6.1 Objectives, policies and guidance

Objective*: Protect marine habitats to maintain environmental values including biodiversity, ecological integrity and ecological functioning.*

Relevant policy and guidelines include:

+ NT EPA Environmental Factors and objectives: Environmental impact assessment general technical guidance (NT EPA, 2021bc);
+ Matters of National Environmental Significance, Significant impact guideline 1.1 (DoE, 2013);
+ Relevant EPBC related recovery plans, conservation advice and management plans;
+ National Strategy for Reducing Vessel Strike on Cetaceans and Other Marine Megafauna (Commonwealth of Australia, 2016b);
+ Anthropogenic Pressures on Darwin Harbour: An IMMRP Monitoring Plan (Version 1). Technical Report No. 11/2020 (Radke and Fortune, 2020);
+ Guidelines for the environmental assessment of marine dredging in the Northern Territory (NT EPA, 2013);
+ Darwin Harbour Strategy (DHAC, 2020); and

+ Darwin Harbour Water Quality Protection Plan (DLRM, 2014).

9.6.2 Potential significant impacts

Project activities

As presented in **Table 9-1**, the following Project activities have the potential to impact on the marine ecosystem:

+ Pre-lay works:
+ Pre-lay trenching along the Project pipeline;
+ Spoil disposal outside of Darwin Harbour;
+ Pre-lay span rectification and foundation installation;
+ Trenching from shore which may include temporary shoreline modifications including the construction of a cofferdam and/ or a temporary groyne;
+ Pipeline installation activities, including post-lay span rectification, trenching and backfill, e.g., rock placement or engineered backfill from the borrow ground outside Darwin Harbour; and
+ Operations activities, specifically maintenance and repair activities.

Planned and unplanned aspects of Project activities

Of the different planned aspects associated with Project activities, seabed disturbance, noise and light emissions have the potential for a significant impact to ecosystems; in particular the following values and sensitivities (refer **Table 9-2**):

+ Conservation significant marine areas;
+ Intertidal and benthic habitats;
+ Marine mammals;
+ Marine reptiles; and
+ Fish, rays and sharks.

Of the unplanned aspects, invasive marine species, marine fauna interaction, marine diesel releases during bunkering or a vessel collision, or a dry gas release from a pipeline rupture during operations have the potential for significant impacts to the following values and sensitivities (refer **Table 9-2**):

+ Conservation significant marine areas;
+ Intertidal and benthic habitats;
+ Marine mammals;
+ Marine reptiles;
+ Fish, rays and sharks;
+ Plankton;
+ Seabirds and migratory shorebirds; and
+ Ecological function and processes and integrity of marine ecosystems.

An assessment of the planned and unplanned aspects that could have a significant impact to the marine ecosystem during construction and operations is presented below.

The key information used, and assumptions made, in assessing potential impacts on marine ecosystems were:

+ Long term monitoring as part of the DLNG facility has not identified any significant impacts associated with installation, or operations activities; and
+ Environmental monitoring data and information collected and reported as part of the INPEX Browse, Ltd monitoring programs (summarised in INPEX Browse, Ltd 2014) present a conservative assessment of the potential impacts from the Project given the significantly lower disturbance footprint (including scale, spatial extent and duration).

9.6.2.1 Conservation significant areas

Construction

Seabed disturbance

The Port Darwin wetlands (NT029 Port Darwin) are listed as a Nationally Important Wetland under the Directory of Important Wetlands in Australia. While there is the potential for Project activities to impact the environment of the wetlands, based on the impact assessment undertaken for coastal processes (**Section 9.4**) and marine environmental quality (**Section 9.5**) and in this section, any impacts will be temporary and localised and are not expected to impact, nor change the value of the wetlands.

The Project Area overlaps habitat critical to the survival of flatback turtles and the flatback turtle BIA (interesting). It also overlaps the BIAs (breeding) for the Australian snubfin dolphin, the Indo-Pacific humpback dolphin and the Indo-Pacific spotted bottlenose dolphin. As presented in the existing environment section above (**Section 7.2**) coastal dolphin populations within the Darwin region occur at low densities, exhibit substantial temporary emigration and have fluctuating population size (Brooks et al, 2017; Griffiths et al, 2020).

While direct changes to the seabed along the Project pipeline, spoil disposal ground and borrow ground will occur as a result of Project activities, the area to be impacted only represents a very small part of these conservation areas and as such, Project activities are not expected to change the underlying value of these areas, nor impact the biologically important behaviours, or prevent those behaviours from occurring during construction activities. There is widespread habitat available in the immediate vicinity that marine fauna are able to access and consequently, no significant change to these conservation significant areas is expected.

The Project Area also overlaps the Charles Point Wide Reef Protection Area in offshore NT waters. The Reef Protection Areas (RPAs) have been established after stock analyses identified the downward trend of golden snapper and jewfish and the Charles Point Wide area covers important deep-water areas to reduce impacts of barotrauma. While there will be direct impact to the seabed in this area and subsequent localised and temporary decrease in water quality, this is only expected to result in temporary behaviour changes to fish during construction. There is not expected to be any significant impact to the RPA and the addition of the Project pipeline will add additional, artificial habitat for reef fish.

Unplanned introduction of IMS

The potential for a significant impact to arise from an unplanned aspect comes for the potential introduction of an IMS. As described above in **Section 9.5.2.2**.

Operations

Seabed disturbance

While seabed disturbance during maintenance and repair activities would disturb the seabed, the spatial and temporal extent of any such activities would be significantly less than during the construction, e.g., focussed on a particular section rather than the entire pipeline. Therefore, potential impacts would be far more localised and temporary and unlikely to have a significant impact on conservation significant areas.

Unplanned introduction of IMS

As vessel-based activities are part of operations, the risk from unplanned introduction of an IMS will remain during operations; however, will not be higher than construction activities with standard management measures in place.

9.6.2.2 Intertidal and benthic habitats

Construction

Seabed disturbance

The installation of the Project pipeline will disturb, and in some areas remove and redistribute seabed, e.g., trenching areas, spoil disposal ground and borrow ground, anchoring areas during pipelay in shallower water and trenching at the shore crossing location. If required, the construction of a cofferdam and/or a temporary rock groyne will also directly impact intertidal habitats.

It is expected that benthic habitat directly below the trenched areas, Project pipeline and stabilisation and protection structures/measures (including span rectification structures and any engineered or rock backfill) will be lost as a result of direct impact from installation. These habitats are well represented throughout the region with native flora and fauna likely to recolonise the pipeline and subsea infrastructure once installed and will take advantage of any new structures/rock backfill, which may increase biodiversity compared to the naturally soft sediments present.

Based on recent habitat mapping work completed, the habitats in the Project Area are dominated by unconsolidated sediment including mud flats, ripples and sediment waves (Siwabessy et al. 2016) colonised by sponges, filterers and octocorals (Galaiduk et al. 2019). While hard substrate and hard coral habitats occur within Darwin Harbour, they occur only in isolated pockets across outer areas of the harbour and away from the Project Area, as does seagrass, in shallow areas outside the main channels and away from the Project Area. Consequently, no direct impact to or loss of hard coral or seagrass habitat is expected.

In addition to these direct impacts, intertidal and benthic habitats are at risk from indirect impacts; primarily from increased turbidity and sedimentation related to seabed disturbance activities.

Mangroves and other intertidal invertebrate animals can be susceptible to smothering from the build-up of sediment that can occur as a result of increased suspended sediments from dredging and/or trenching campaigns. During environmental monitoring, INPEX Browse, Ltd (2014) monitored the height of the sediment bed to measure sedimentation at five key mangrove assemblages at ten sites. The highest mean net sedimentation measured over the monitoring period was 27.4 mm at the site closest to dredging (which was also adjacent to a recently constructed boat ramp which INPEX Browse, Ltd reported would likely have influenced the sediment dynamics because of the construction of a groyne at the ramp). The greatest measured sediment level was well below the 50 mm of dredge-derived sediment that could potentially impact the mangroves and INPEX Browse, Ltd (2014) reported that no dredging-related effects on mangrove community health were observed at any of the monitoring sites. Consequently, given the significantly smaller trenching campaign for the Project, significant impacts to mangroves and intertidal habitats are unlikely.

Similarly, other benthic communities (particularly corals and sponges) can be impacted by suspended sediment through three primary cause effect pathways: light reduction, increased suspended sediment concentrations, and sediment deposition (smothering).

Studies undertaken as part of the Western Marine Science Institution (WAMSI) Dredging Science Node (WAMSI, 2019) report that both sponges and hard corals are well adapted to sediment and are resilient to increased suspended sediment loads for extended periods of time. Given the seasonally turbid nature of the Project Area, it is expected that these benthic communities would be well adapted to such conditions.

For sponges, adaptations include incorporation of sediment into their tissue (skeleton reinforcement), forming sediment crusts (providing shade, camouflage and shelter from grazers and desiccation), ability to anchor in soft sediments (sometimes partially embedded), and passive or active cleaning mechanisms (including self-cleaning surfaces, mucus production and tissue sloughing). These tolerance mechanisms come at a cost (depletion of energy reserves, reduced sponge health), suggesting that longer term exposure to such extreme sediment disturbance conditions is likely to result in mortality.

For corals, WAMSI (2019) reports light attenuation and sediment deposition leading to smothering as the key cause effects pathways that define zones of high impact (mortality). Most can tolerate a 3-fold decrease in light levels, and a combination of 10 mg/L and 2.3 mol photons/m^2/day over a 42-day period. Light attenuation is directly proportional to suspended sediment concentrations.

Trenching for pipeline installation will result in pulses of increased turbidity, suspended solids and subsequent reduction in light availability. Periods of increased turbidity will coincide with natural peaks in turbidity, i.e., under spring tide conditions, but there will also be periods of lower turbidity and higher light levels during the neap tide conditions. Consequently, benthic habitats will not be exposed to a continuous period of increased turbidity and lower light, and fine sediment particles that may land on sponges and other filter feeders in the area are likely to be resuspended and disperse with the tidal cycle.

The greatest suspended sediment levels are likely to occur at the shore crossing location in shallow water. The closest hard coral habitats are to the south at Channel Island, and further north-west at Weed Reef (both approximately 2 km from the pipeline route). Sediment plume modelling conducted by INPEX Browse, Ltd (2010a) predicted only low (<3 mg/L) median levels of suspended sediment concentrations for its pipeline dredging activity, with suspended sediment concentrations at Channel Island coral communities predicted to experience concentrations of 10 mg/L above background less than 0.01% of the time. Similarly, corals at Weed Reef were predicted to be exposed to low concentration plumes (5 mg/L) less than 0.01% of the time (INPEX Browse, Ltd 2010a). Based on these predictions, the fact that INPEX did not observe any impact to coral communities (INPEX

Browse, Ltd 2014) and the fact that the Ichthys pipeline is ~1 km closer to the Channel Island corals, the Project is not expected to impact hard coral communities.

When considering seagrass, no impact to seagrass is expected given the closest seagrass to the Project pipeline is Fannie Bay. For seagrass beds located outside the harbour and south of the proposed spoil disposal ground, the Ichthys environmental monitoring (INPEX Browse, Ltd 2014) reported that its activities did not appear to cause measurable environmental impact to seagrass and its spoil disposal ground was both closer to seagrass beds and received significantly more spoil than proposed for the Project.

Considering the low sensitivity and regional representation of the habitats within the Project Area, and when considering data and conclusions from the INPEX Browse, Ltd environmental monitoring program (INPEX Browse, Ltd 2014) where only relatively small increases in turbidity were observed for a much larger dredging campaign and no impacts to seagrass were observed, it is concluded that direct or indirect impacts from the proposed activities will not substantially change or adversely impact on biodiversity or ecological integrity of benthic communities.

Unplanned introduction of IMS

The potential for a significant impact from an unplanned aspect comes for the potential introduction of an IMS. As described above in **Section 9.5.2.2**.

Unplanned marine diesel release

Benthic habitats (i.e. filter feeders, macroalgae, seagrass and corals) are vulnerable to hydrocarbons, noting entrained hydrocarbons from a MDO release are expected to remain in the top 10 m of the water column.

Lethal and/or sub-lethal effects to filter feeders from hydrocarbons include mortality and changes in population recruitment, growth and reproduction leading to changes in community composition and structure (Wei et al., 2012). Filter feeders are particularly susceptible as they are likely to directly ingest hydrocarbons while feeding. This may cause mortality or sub-lethal impacts such as alteration in respiration rates, decreases in filter feeding activity and reduced growth rates, biochemical effects (Keesing and Edgar, 2016). However, as the hydrocarbon concentration decreases and weathers, the communities are expected to recover. In the worst-case scenario with MDO, the rapid evaporation and weathering coupled with entrained MDO largely being concentrated in surface waters, filter feeders are unlikely to suffer prolonged exposure and significant impacts are not expected.

Mangrove habitat can suffer from hydrocarbons and hydrocarbons deposited on the aerial roots can block the pores used by the plants to breathe or interfere with the trees' salt balance resulting in sub-lethal and potential lethal effects. Mangroves can also be impacted by entrained aromatic hydrocarbons that may adhere to sediment particles. In low energy environments such mangroves, deposited sediment-bound hydrocarbons are unlikely to be removed naturally by wave action and may be deposited in layers by successive tides (National Oceanic and Atmospheric Administration, 2014).

However, given the low portion of persistent hydrocarbon in MDO and the rapid weathering of MDO, hydrocarbons in mangrove environments from an MDO spill are not expected to persist and long-term and impacts are not expected to be significant.

Tidal mudflats, like mangroves, are a low energy environment and are, therefore, susceptible to potential impacts from persistent surface or stranded hydrocarbons. Hydrocarbons in contaminated sediments can persist for years and result in significant impacts, particularly on benthic infauna, and their dependent migratory shorebird populations (Duke and Burns, 2003). Saenger (1994) noted that mudflats were the most severely affected habitat two years after the Gulf War spill, with no sign of living epibiota. However, the hydrocarbon type in the Gulf was a crude oil which has a larger fraction, compared to MDO, of persistent components. Given the low level of persistent hydrocarbons in MDO and the rapid evaporation and weathering, prolonged exposure is not expected and significant impacts are not expected.

Seagrass in the subtidal and intertidal zones have different degrees of exposure to hydrocarbon spills. Subtidal seagrass is generally considered much less vulnerable to surface hydrocarbon spills than intertidal seagrass, primarily because freshly spilled hydrocarbons float under most circumstances. Dean et al. (1998) found that hydrocarbons mainly affect flowering, therefore, species that are able to spread through apical meristem growth (growth at the roots tips) are not as affected (such as Zostera, Halodule and Halophila species).

Potential impacts may include reduced photosynthesis (due to direct contact or through absorption of the water-soluble fraction, which is most commonly associated with MDO and condensate spills as they entrain within the water column) and a reduction in tolerance to other stress factors (Runcie et al., 2010; Taylor and Rasheed, 2011). Seagrass in the intertidal zone is particularly vulnerable as it may come into direct contact with surface hydrocarbons, as well as entrained components, which can smother and kill seagrasses if it coats their leaves and stems (Taylor and Rasheed, 2011). This conclusion is supported by Howard et al. (1989) who noted that surface hydrocarbon spills which become stranded on the seagrass and smother it during the rise and fall of the tide can result in reduced growth rates, blackened leaves and mortality. Wilson and Ralph (2011) concluded that long-term impacts to seagrass are unlikely unless hydrocarbon is retained within the seagrass meadow for a sustained duration.

Given the location of seagrass beds in relation to Project activities, the rapid evaporation and weathering coupled with entrained MDO largely being concentrated in surface waters, seagrass beds are unlikely to suffer prolonged exposure and significant impacts are not expected.

Water soluble hydrocarbon fractions associated with surface slicks are also known to cause high coral mortality (Shigenaka, 2001) via direct physical contact of hydrocarbon droplets to sensitive coral species (such as the branching coral species). Hydrocarbons in the water column resulting from a surface release (e.g. from a vessel collision or bunkering incident) will be concentrated in surface waters. Entrained hydrocarbons are expected to be found in the top 0-10 m of water. On this basis, benthic primary producer habitats, such as hard corals, are unlikely to be affected as they typically do not occur near surface waters.

Inter-tidal and shallow water corals may be impacted by floating and entrained hydrocarbons. Impacts may include increased mortality and sub-lethal effects such changes in feeding, bleaching (loss of zooxanthellae), increased mucous production resulting in reduced growth rates and impaired reproduction (Negri and Heyward, 2000). Given the patchy distribution of inter-tidal and shallow water corals around the Project Area, the rapid evaporation and weathering coupled with entrained MDO largely being concentrated in surface waters, coral habitats are unlikely to suffer prolonged exposure and significant impacts are not expected.

Operations

<u>Seabed disturbance</u>

Once installed, the ongoing operations of the Project will not impact intertidal and benthic habitats.

If maintenance and repair were required to the Project pipeline during operations, e.g., from typical freespan rectification through to having to repair/replace a section of pipe that could have been damaged, these activities will disturb the seabed and result in temporary and localised decreases in water quality. It should be noted that the likelihood of this occurring is low and potential impacts would be similar for other projects such as Bayu-Undan to Darwin pipeline and the Ichthys pipeline.

However, compared to the construction phase, the spatial and temporal extent of any such maintenance and repair activities during operations would be significantly less than during the construction phase due to them being related to a particular section rather than the entire Project pipeline. Therefore, potential impacts would be far more localised and temporary. As such, it is unlikely that planned operations aspects would have a significant impact on intertidal and benthic habitats.

Unplanned introduction of IMS

As vessel-based activities are part of operations, the risk from an unplanned introduction of IMS will remain during operations. However, as described above, the introduction of an IMS leading to a significant impact to intertidal and benthic habitats is not expected.

Unplanned marine diesel release

As vessel-based activities are part of operations, the risk from an unplanned marine diesel release will remain during operations. As vessels supporting operations will be smaller support vessels compared to the large DP pipelay vessel, the worst-case credible scenario is considered to be no greater than 350 m3. Consequently, and as described above, any impacts to water quality would be temporary and localised in nature and not have a significant impact on marine environmental quality.

9.6.2.3 Marine mammals

Construction

Noise emissions

There will be a period of increased noise emissions during construction activities due to the operation of vessels, operation of survey and positioning equipment and from helicopters supporting the installation activity. Underwater noise emissions will be temporary and will take place for a relatively short period of time in any one location.

Noise associated with vessel activity that could impact marine fauna includes noise generated by vessel thrusters, engines and propellers, as well as noise emitted onboard which is converted to underwater noise through the hull (i.e., from heavy machinery). The main source of vessel noise will be from propellers or thrusters.

Noise will also be generated during the Project from trenching, installation activities including span rectification activities, placement of the Project pipeline and stabilisation and protection structures (including mattresses).

Helicopters will also generate noise and the main source of noise emissions from helicopters is the engines and the rotor blades. The landing and take-off of helicopters would be the only time noise emissions from helicopters would occur in the Project Area as this is when helicopters are at their lowest (and therefore closest to the surface of the water).

Underwater noise emissions have the potential to affect marine mammals as they use sound for a range of functions such as social interaction, foraging and orientation. Responses and effects depend on a number of factors, including distance from the sound source, water depth and bathymetry, the animal's hearing sensitivity, type and duration of sound exposure and the animal's activity at time of exposure. Broadly, the effects of sound on marine fauna can be categorised as:

+ Acoustic masking – Anthropogenic sounds may interfere with, or mask, biological signals, therefore reducing the communication and perceptual space of an individual;
+ Behavioural response – Behavioural impacts will depend on the audible frequency range of each potential receptor in relation to the frequency of the noise, as well as the intensity of the noise. Behavioural changes vary significantly and may include temporary avoidance, increased vigilance, reduction in foraging and reduced vocalisations; and
+ Physiological impacts – Auditory threshold shift (temporary and permanent hearing loss) – marine fauna exposed to intense sound may experience a loss of hearing sensitivity, or even potentially mortal injury. Hearing loss may be in the form of a temporary threshold shift (TTS) from which an animal recovers within minutes or hours, or a permanent threshold shift (PTS) from which the animal does not recover.

Available threshold criteria associated with behavioural and physiological impacts for sensitive receptors have been derived from a number of studies (NMFS, 2018; NMFS, 2014; Popper et al., 2014; Southall et al., 2019). These criteria have been compared with measured and predicted sound levels for different sound sources to assess potential impacts.

If a cofferdam is required to be constructed, then sheet piles may need to be hammered in, i.e., using a vibro hammer or an impact hammer. Compared to piling for a jetty or similar, sheet piling generally requires more frequent strikes from a much lower energy hammer and therefore the risk of noises impacts are lower than for more substantial pile driving. The cofferdam is planned to be constructed primarily above the water line, i.e., working up and down the shoreline with the tide, which will reduce propagation of sound underwater and reduce exposure to marine receptors. Marine fauna within close proximity of the sheet piling will be exposed to cumulative noise if they do not flee the disturbance site, but mobile fauna are expected to be unaffected by this piling noise, other than behavioural changes to avoid it.

Engineering studies continue to evaluate whether a cofferdam will be required to be constructed. Should it be identified that it is required, sound propagation modelling will be undertaken to inform management of the cofferdam construction, including the need for mitigations and controls to reduce impacts to the values and sensitivities of the marine ecosystem.

Santos has used the information presented in the Ichthys draft EIS (INPEX Browse, Ltd, 2010a) to inform this referral.

Ichthys undertook modelling of sound propagation to evaluate potential impacts from noise generated by drill and blasting (not proposed for this Project) and from pile driving to construct a product loading jetty. While the scenarios modelled for the Ichthys project are not comparable to the current Project activities, they do provide an assessment of what the areas of potential impact may be from a significantly greater sound source and thus, provide a very conservative comparison for this project. It should be noted that given the close proximity of the existing Ichthys pipeline and the Project pipeline, it can be assumed that the seabed conditions and other environmental parameters affecting the propagation of underwater noise are broadly similar.

INPEX Browse, Ltd (2010a) used underwater noise exposure thresholds available at the time and derived 'safe ranges' for key marine fauna during blasting and pile driving. Since the development of sound propagation modelling completed by Ichthys, the exposure criteria for marine mammals have been updated (Southall et al. 2019). To understand the impact of noise on marine mammals, methods have been developed by a panel of experts in acoustics and marine mammal science to determine noise exposure levels from anthropogenic sources which can cause; behavioural responses, auditory sensitivity effects including temporary threshold shifts (TTS) and permanent threshold shifts (PTS) (Southall et al. 2019). The main update for the exposure criteria for marine mammals is that they are now split into groups depending on their hearing sensitivity and the key dolphin species in the harbour are classified as high-frequency cetaceans. Fish noise exposure thresholds have also been updated by Popper et al. (2014) who presented all thresholds as peak sound pressure levels even for fish without swim bladders since no data for particle motion exist.

The Ichthys modelling showed effect zones of similar magnitude to those proposed as generic effect zones by Popper et al. (2014) for fish. They both indicate high to moderate risk of adverse effects from noise for fish within 100s of metres from a blasting site. The INPEX Browse, Ltd modelling outputs based on the older thresholds indicated effects distances to marine mammals of around 1000 m and behavioural responses (avoidance) are likely at greater ranges, which would reduce the likelihood that mobile marine fauna would enter the zone where they may suffer injurious noise levels.

Based on this, we can conclude that distance from source within which marine mammals may experience adverse effects from underwater noise created during sheet piling for the installation of a cofferdam will be much less.

While dugongs may occur in the Project Area, dugongs spend most of their time in shallow tidal and subtidal seagrass meadows. There are no assessments for impacts of vessel noise on dugongs (sirenians) using the Southall et al. (2019) criteria. As their frequency-weighting is most similar to high-frequency cetaceans, and their thresholds are higher (as they are less sensitive), results for vessel noise impacts on high-frequency cetaceans have been used as a proxy for those on dugong, noting that this is likely to be conservative. Therefore, it is not expected that dugongs would be significantly impacted by the piling noise other than temporary behavioural changes to avoid it.

<u>Unplanned marine fauna interaction</u>

The risk of vessel strike to marine fauna is inherent to movements of all vessel types. A review of records of vessel collisions with marine megafauna reported a higher number of collisions with whale-watching boats, naval ships and container ships (DoEE, 2017b). The recovery plans and conservation advice for whales (blue, humpback, sei and fin whales) recognise vessel strikes/disturbance as a key threat to these EPBC listed species.

Vessels associated with construction may present a potential risk to marine fauna. Due to the slow speed of the pipelay vessel (<1 knot) it is considered to be effectively immobile and therefore does not present a vessel collision risk to marine fauna. The impact from vessel interactions with marine fauna can be as minimal as temporary behavioural changes, ranging to severe impacts, such as injury or mortality resulting from vessel strikes. The potential risk of a collision with marine fauna is directly related to the abundance of marine fauna and number of vessels in the Project Area, and the actual likelihood of a collision occurring is also influenced by vessel speed. As presented in DoEE's (now DoAWE) National Strategy for Reducing Vessel Strike on Cetaceans and Other Marine Megafauna

(DoEE 2017), the majority of the reported vessel collisions have occurred along eastern or south-eastern Australia, with no reported incidences in NT waters.

Vessel speed has been demonstrated to be a key factor in relation to collision with marine fauna, particularly cetaceans and turtles, with faster moving vessels posing a greater collision risk than slower vessels (Hazel et al., 2009; Jensen and Silber, 2004; Laist et al., 2001; DoEE 2017). Laist et al. (2001) suggest the most severe and lethal injuries to cetaceans are caused by vessels travelling at 14 knots or faster.

The behaviour of the individual may also influence the potential for a collision with a vessel. For example, it has been suggested that individual whales engaged in feeding, mating or nursing behaviours may be more vulnerable to vessel collision as they are distracted by these activities and consequently less aware of their surroundings (Laist et al., 2001). A study on the behavioural responses of blue whales to vessels showed limited behavioural response when being approached by ships (McKenna et al., 2015, cited in DoEE, 2016).

Pygmy blue whales, Bryde's whale and Omura's whales have been recorded along the northern section of the original Barossa GEP route, but only in low numbers. As these species are likely to transit these areas, it is possible that these species may also transit the offshore NT waters though it is noted that there are no BIAs or other critical habitat for these whale species within the Project Area or the broader region. Considering this, and the wide distribution of whale species, vessel movements are not anticipated to cause any effects at a population or migration level.

The primary migratory route for humpback whales near the Kimberley coastline and up to Camden Sound (**Section 7.2.4.2**) is well understood and relatively few humpback whales have been known to travel north of Camden Sound (Jenner et al., 2001). In addition to this, as noise monitoring in the Barossa offshore development area did not record any humpback whales, it is highly unlikely that there would be any vessel related interactions with this species.

Both sei and fin whales have a wide distribution throughout offshore waters and therefore may pass through the Project Area in low numbers (**Section 7.2.4.2**). However, considering vessels will be limited to 8 knots within the Project Area, and the mobility of these species, it is highly unlikely that activity vessels will adversely interact with any individuals.

Collisions with smaller cetaceans, such as dolphins, are very infrequent due to the mobility of these smaller cetaceans, which allows them to avoid vessels. Dolphins may pass through the Project Area, particularly along the southern end however collisions between activity vessels and dolphin species are considered possible. The Indo-Pacific humpback dolphin is present in Darwin Harbour.

While dugongs may occur in the Project Area, dugongs spend most of their time in shallow tidal and subtidal seagrass meadows. Therefore a few individuals may travel through the Project Area; however, if any vessel strikes do occur, they are unlikely to threaten the overall viability of the population as the plausible number of vessels strikes is very small.

<u>Unplanned marine diesel release</u>

Cetaceans are highly mobile and are known to transit through the region, though primarily outside Darwin Harbour and typically further offshore within Commonwealth waters. Studies and field observations suggest that cetaceans may be able to detect and avoid hydrocarbon slicks (Geraci and St Aubin, 1988). Cetaceans are vulnerable to the effects of surface hydrocarbons due to the need to surface and breathe. Direct contact with surface slicks and inhalation of vapours may irritate eyes, airways and lungs. Lethal or sub-lethal effects will depend on the concentration of the hydrocarbons and the duration of exposure. Potential impacts to dugongs are expected to be similar to cetaceans given their sensitivity to hydrocarbon exposure is likely to be similar.

As described in **Section 9.5.2.1**, Project oil spill modelling will be completed to inform spill preparedness and response arrangements including the need for oiled wildlife response.

Given spilled MDO is expected to disperse and weather rapidly, the potential for impacts to cetaceans will be concentrated around the release location and limited to individuals and no significant impacts are expected.

Operations

Noise emissions

During operations, the only noise emissions will be vessel-based and indistinguishable from any other vessel activity within and on the approach to Darwin Harbour. As such, noise emissions during operations are unlikely to have a significant impact on marine mammals.

Unplanned marine diesel release

As vessel-based activities are part of operations, the risk from an unplanned marine diesel release will remain during operations. As vessels supporting operations will be smaller support vessels compared to the large DP pipelay vessel, the worst-case credible scenario is considered to be no greater than 350 m3. Consequently, and as described above for the construction phase, impacts to marine mammal individuals, populations or viability are not expected.

Dry gas release from pipeline rupture during operations

As presented in **Section 9.5.2.3** above, a worst-case pipeline rupture during operations would result in a release of dry gas to the environment which would move towards the surface forming a large plume in the water column and dispersing into the atmosphere. Consequently, the gas cloud may result in impacts to air-breathing fauna, such as marine mammals, with the worst-case outcome being animals breathing in the immediate vicinity of the release being asphyxiated, potentially resulting in mortality. Given the dispersion of gas into the atmosphere, this potential effect would be highly localised to the release location and short term only.

When considering the controls and mitigations presented in **Section 9.5.2.3** above, the risk of a dry gas release from a pipeline rupture during operations and impact marine mammals is considered to be low.

9.6.2.4 Marine reptiles

Construction

Noise

As described in the marine mammal section above, underwater noise emissions have the potential to affect marine fauna, including marine turtles and responses and effects depend on a number of factors, including distance from the sound source, water depth and bathymetry, the animal's hearing sensitivity, type and duration of sound exposure and the animal's activity at time of exposure.

Little is known regarding masking in marine turtles, and behavioural reactions have been found to be highly context specific, with behavioural sensitisation and habituation affecting the onset threshold for reactions and impacts (Ellison et al., 2012). Behavioural changes, such as avoidance and diving, are only predicted for individuals in close proximity to the activity vessels and there is a low risk of any injury to marine turtles from vessel noise.

Based on the criteria for vessel noise exposure for turtles adapted from Popper et al. (2014) there is a low risk of injury to marine turtles from vessel noise. Temporary behavioural changes, such as avoidance and diving, are only predicted for individuals in close proximity to the activity vessels (high risk of behavioural impacts within tens of metres of a vessel and moderate risk of behavioural impacts within hundreds of metres of a vessel). There is a high risk of masking within hundreds of metres of the vessel, and a moderate risk of masking within thousands of metres from the vessel. Little is known regarding masking in marine turtles, and behavioural reactions have been found to be highly context specific, with behavioural sensitisation and habituation affecting the onset threshold for reactions and impacts (Ellison et al., 2012). However, given the relatively low-level increase in sound over a short term period, it is unlikely that vessel noise will cause significant masking impacts in turtles.

Impacts to marine turtles from helicopter noise is expected to be limited to short term behavioural impacts (i.e. diving or swimming rapidly) when the helicopter is taking off, based on measurements of helicopter noise (maximum received level of 109 dB re 1 uPa and only detectable underwater for 11 to 38 seconds) (based on transit speed), depending on water depth (Richardson et al., 1995). Such impacts are unlikely to result in substantial impacts to marine turtle populations or distribution.

In relation to potential impacts to marine reptiles if a cofferdam is required to be constructed, taking the same comparison to the Ichthys modelling described above, outputs based on the older thresholds indicated effects distances to marine turtles of around 1000 m (as for marine mammals) and behavioural responses (avoidance) are likely at greater ranges, which would reduce the likelihood that mobile marine fauna would enter the zone where they may suffer injurious noise levels.

Based on this, the distance from source within which marine turtles may experience adverse effects from underwater noise created during sheet piling for the installation of a cofferdam will be much less.

There is limited information on the effects of noise on seasnakes. A current research project investigating the impacts of seismic surveys found that hearing sensitivity of seasnakes is similar to species of fish without a swim bladder. Therefore, it is considered that there is a moderate risk in the near and intermediate distances (which extends hundreds of metres) of behavioural impacts to seasnakes, with the impacts being limited to temporary avoidance of the area. Such impacts are unlikely to result in substantial impacts to seasnake populations or distribution.

<u>Light emissions</u>

Activity vessels will have external lighting to provide a safe working environment and to comply with relevant maritime navigation requirements at night. Light from the pipelay vessel operating in the offshore NT waters into Darwin Harbour will be the most visible as it is the largest vessel and therefore has been used to determine the worst-case distance that light may be visible for activity vessels.

Light emissions associated with the Project may present a risk to marine fauna in the open waters and cause a temporary change in movement patterns and/or behaviour, such as the attraction or disorientation of individuals. Artificial lighting can affect several marine fauna including seabirds and migratory shorebirds, marine turtles as well as sharks/rays and other fish.

Given this, light modelling was undertaken to predict the extent of biologically relevant light spill from the largest pipelay vessel and construction vessel that may be used for this Project, e.g. the Audacia pipelay vessel and Oceanic construction vessel which lay pipe in the offshore NT waters and into Darwin Harbour. Light spill was modelled for each vessel independently, and when operating side by side.

Specifics of the respective vessel's lighting design and luminaire specifications were applied to the Illumina Artificial Light At Night (ALAN) model (Aube et al., 2005). The Illumina model is a 3D model that accounts for both line of sight and atmospheric scattering, allowing the attenuation of light over distance and extent of light glow to be modelled.

Since light sources (i.e. individual luminaires) can be placed individually with the area of interest, the model is able to replicate specific lighting designs in terms of light type, spectral distribution, height and orientation of individual luminaires, including any shielding, increasing model accuracy. This information was extracted from lighting layout drawings and light manufacturer data sheets for both the Audacia pipelay vessel and Oceanic construction vessel. Both models assumed that all lights on the vessels were turned on (apart from search lights which are only used in an emergency situation) with no additional shielding (other than that provided inherently by the vessel structures). Vessels were also orientated north-south. Cloud cover was assumed to be zero, and therefore, the simulation has no contribution of light from cloud reflectance. Model outputs are provided in radiance ($W/m^2/sr$, where W = watts, m^2 =metres squared and sr = steradian).

In the absence of any published or generally accepted units of measurement, or scale, for measuring the impact of artificial light at night on turtle hatchlings, moonlight is used as a proxy. Output from the light model (radiance, units of $Watts/m^2/sr$) was converted to units of full moon equivalents to provide biological relevance to the radiance output.

The modelling results showed that the pipelay vessel will have a larger light glow and that the light glow when the vessels are side by side is only slightly higher (Pendoley, 2020). At ~3.3 km from the pipelay vessel and 512 m from construction vessel, and 3.375 (3.4) km for both vessels, radiance is equivalent to 0.1 radiance of a full moon and, therefore, light will be visible but unlikely to result in a behavioural impact, i.e. not biologically relevant (Pendoley, 2020). Behavioural impacts may start to occur at distances within ~3.3 km of the pipelay vessel, or 3.4 km if vessels side by side.

The closest nesting beaches from the Project Area are the south-west area of Bathurst Island (~30 km away) and to the south-west outside Darwin Harbour (~ 20 km from Project Area) and no turtle nesting beaches inside Darwin Harbour have been reported. Consequently, there are no nesting beaches within the 3.4 km within which behavioural impacts may start to occur, nor the 20 km precautionary threshold stated in the National Light Pollution Guidelines for Wildlife (DoEE, 2019). Consequently, hatchling turtles are not expected to be impacted (misorientated or disorientated) by light emissions from the Project.

Once hatchlings enter the ocean, they are thought to employ a survival strategy that involves rapid dispersal away from predator rich nearshore habitats to reach deeper waters where they develop into juveniles. An internal compass set while crawling down the beach, together with wave cues, are used to reliably guide them offshore (Lohmann & Lohmann, 1992; Stapput & Wiltschko, 2005; Wilson et al., submitted). In the absence of wave cues however, swimming hatchlings have been shown to orient towards light cues (Lorne & Salmon, 2007; Harewood & Horrocks, 2008) and in some cases, wave cues were overridden by light cues (Thums et al., 2013, 2016). Consequently, there is potential for hatchlings at sea to be attracted to light emissions if they are carried by currents to within ~3.3 km of the pipelay vessel, ~500 m of the construction vessel, or 3.4 km of both vessel when they are operating simultaneously.

Given the distance they would have to travel, it is unlikely, but if they got carried to within 3.4 km and if attraction did occur, (unlikely based on the light glow modelling), and assuming that a hatchling can actually make it to the light source (given individual variability in swimming speed and direction, and localised water movements) it is likely that individuals would remain entrapped in light for short periods (Wilson et al., 2018; Thums et al., 2010). During that time, there is the potential for:

+ increased energy expenditure as hatchlings swim against currents towards light sources and when entrapped in light spill, with potential effects to individual fitness; and
+ increased risk of predation while silhouetted in areas of light spill.

But even at worst case where individuals are trapped until dawn, any disruption to hatchling dispersal behaviour is expected to represent an insignificant proportion of the total annual number of hatchlings and would not impact turtle populations, nor recovery. Similarly, any increased mortality from predation or increased energy expenditure will likely be limited to a negligible proportion of the annual number of hatchlings for the given genetic stocks.

Although the Project Area overlaps important internesting habitat, the number of individuals likely to be present is expected to be limited. Suitable internesting habitat for flatback turtles is defined as water depths shallower than 16 m (Whittock et al., 2016 in Pendoley, 2019).

If individual turtles are present, light emissions from any of the vessels are unlikely to be of concern. There is no evidence, published or anecdotal, to suggest internesting turtles are impacted by light from offshore vessels, and nothing in their biology would indicate this as a plausible threat (Pendoley, 2019; Witherington and Martin, 2003). In addition, given the existing vessel traffic and light sources within Darwin Harbour (i.e. Darwin township and Port facilities), it is considered unlikely that the Project vessels would significantly add to the existing vessel traffic, vessel-based activities, or lighting in Darwin Harbour and beyond.

Consequently, significant impact to marine reptiles from light emissions is not expected.

<u>Unplanned marine fauna interaction</u>

The recovery plans for marine turtles recognise vessel strikes/disturbance as a key threat to these EPBC listed species. The plan also notes that while a vessel strike can be fatal for an individual turtle, vessels strikes (as a standalone threat) have not been shown to cause declines at a population or stock level and have considered vessel disturbance to be of minor consequence to turtle populations in the NT (DoEE, 2017a).

As described above for marine mammals, the risk of vessel strike to marine fauna is inherent to movements of all vessel types and is directly related to the abundance of marine fauna and number of vessels in the Project Area. While marine turtles are present in the Project Area, as there are no nesting beaches within Darwin Harbour or in the Project Area in offshore NT waters, any turtles present in the Project Area will likely just be transiting through.

Vessel speed has been demonstrated to be a key factor in relation to collision with marine fauna, particularly cetaceans and turtles, with faster moving vessels posing a greater collision risk than slower vessels (Hazel et al., 2009; Jensen and Silber, 2004; Laist et al., 2001; DoEE, 2017b). Laist et al. (2001) suggest the most severe and lethal injuries to cetaceans are caused by vessels travelling at 14 knots or faster.

Turtles will typically avoid vessels by rapidly diving, however, their ability to respond varies greatly depending on the speed of the vessel. Hazel (2009) reported that the number of turtles that fled vessels decreased significantly as vessel speed increases. Turtles are also adapted to detect sound in water (Popper et al. 2014) and will generally move from anthropogenic noise generating sources, including vessels, within their detection range (pers. comm. M. Guinea, CDU, 2015).

As the pipelay vessel will be travelling at very low speeds the risk of coming into contact with turtles is low as it is expected turtles will dive or move away from the vessels. Furthermore, given the high-level of existing vessel traffic within Darwin Harbour, it is considered unlikely that the Project vessels would significantly add to the existing vessel traffic and vessel-based activities.

Vessel strike is not one of the threats identified in conservation advice for sea snakes and it would seem an unlikely event. Individual seasnakes may transit through the Project Area however if any vessel strikes do occur, they are unlikely to threaten the overall viability of the population as the plausible number of vessels strikes is very small.

Similarly, while Saltwater crocodiles are present in the Project Area, they are not expected to be either directly, nor indirectly impacted by the pipeline installation activities given their mobile nature and wide distribution.

Unplanned marine diesel release

Marine turtles are susceptible to the effects of hydrocarbon spills during all life stages (National Oceanic and Atmospheric Administration, 2010). They are in frequent contact with the sea surface and show little avoidance behaviour in response to the presence of surface hydrocarbons, which makes them vulnerable to coating and inhalation of toxic vapours.

Contact with surface slicks or entrained hydrocarbon can therefore result in hydrocarbon adherence to body surfaces (Gagnon and Rawson, 2010) causing irritation of mucous membranes in the nose, throat and eyes leading to inflammation and infection (National Oceanic and Atmospheric Administration, 2010). Oiling can also irritate and injure skin which is most evident on pliable areas such as the neck and flippers (Lutcavage et al., 1995). Given the non-persistent nature of the hydrocarbon, along with the expected rapid weathering of surface hydrocarbons in the tropical environment, the timeframe during which turtles may be exposed to hydrocarbons above impact thresholds is low. Add to this that there are no nesting beaches within Darwin Harbour and only adult turtles are likely to be present in the Project Area and will likely be transiting and so have a reduced risk of exposure in the event of a marine diesel release. Consequently, the potential for a significant impact is considered low.

Seasnakes may be vulnerable to hydrocarbon spills due to their need to surface to breathe and may spend time at the sea surface to bask in the sun however little information is available to describe the effects of hydrocarbon spills on seasnakes. Seasnakes are expected to be distributed around shallow banks and shoals and therefore only low numbers are expected to be impacted and a significant impact to seasnakes is considered unlikely.

As described in **Section 9.5.2.1**, Project oil spill modelling will be completed to inform spill preparedness and response arrangements including the need for oiled wildlife response.

Operations

Noise and light emissions

During operations, the only noise and light emissions will be vessel-based and indistinguishable from any other vessel activity within and on the approach to Darwin Harbour. As such, noise and light emissions during operations are unlikely to have a significant impact on marine reptiles.

Unplanned marine diesel release

As vessel-based activities are part of operations, the risk from an unplanned marine diesel release will remain during operations. As vessels supporting operations will be smaller support vessels compared to the large DP pipelay vessel, the worst-case credible scenario is considered to be no greater than 350 m3. Consequently, and as described above for the construction phase, impacts to marine reptiles, individuals, populations or viability are not expected.

Dry gas release from pipeline rupture during operations

As presented in **Section 9.5.2.3** above, a worst-case pipeline rupture during operations would result in a release of dry gas to the environment which would move towards the surface forming a large plume in the water column and dispersing into the atmosphere. Consequently, the gas cloud may result in impacts to air-breathing fauna, such as marine reptiles, with the worst-case outcome being animals breathing in the immediate vicinity of the release being asphyxiated, potentially resulting in mortality. Given the dispersion of gas into the atmosphere, this potential effect would be highly localised to the release location.

When considering the controls and mitigations presented in **Section 9.5.2.3** above, the risk of a dry gas release from a pipeline rupture during operations is considered to be low.

9.6.2.5 Pelagic and Demersal Fish Communities (including rays and sharks)

Construction

Noise emissions

The criteria defined in Popper et al. (2014) for continuous noise sources indicates that vessel noise has a low risk of resulting in mortality and a moderate risk of physiological impacts when fish are within tens of metres of a vessel. The most likely impacts to fish from noise will be behavioural responses. Popper et al. (2014) identified a moderate risk of behavioural impacts to fish in near (tens of metres) and intermediate distances (hundreds of metres) from the noise source. Masking in fish could also occur within thousands of metres under a worst-case scenario.

Impacts to fish from underwater noise generated by vessel operations are unlikely to result in substantial impacts to populations or distribution given that impacts are likely to be limited to physiological impacts in individuals located within tens of metres of the vessel, behavioural impacts in individuals located within hundreds of metres of the vessel and masking of fish within thousands of metres. Fish are considered unlikely to remain in proximity to vessels and are therefore unlikely to be exposed to sound at the above thresholds.

Unplanned marine diesel release

Fish mortalities are rarely observed to occur as a result of hydrocarbon spills (International Tanker Owners Pollution Federation, 2011). This has generally been attributed to the possibility that pelagic fish are able to detect and avoid surface waters underneath hydrocarbon spills by swimming into deeper water or away from the affected areas. Fish that have been exposed to dissolved aromatic hydrocarbons are capable of eliminating the toxicants once placed in clean water, hence, individuals exposed to a spill are likely to recover (King et al., 1996). Where fish mortalities have been recorded, the spills (resulting from the groundings of the tankers Amoco Cadiz in 1978 and the Florida in 1969, which were significantly bigger than the worst-case credible spill scenario considered in this referral) have occurred in sheltered bays which limited the ability of fish to access clean water and eliminate toxicants. Given the nature and scale of the credible spill scenario and the environment of the credible release locations, impacts to pelagic and demersal fishes are expected to be highly localised and temporary and no significant impact is expected.

As described in **Section 9.5.2.1**, Project oil spill modelling will be completed to inform spill preparedness and response arrangements including the need for oiled wildlife response.

Operations

<u>Noise emissions</u>

During operations, the only noise will be vessel-based and indistinguishable from any other vessel activity within and on the approach to Darwin Harbour. As such, noise and light emissions during operations are unlikely to have a significant impact on fish, rays and sharks.

<u>Unplanned marine diesel release</u>

As vessel-based activities are part of operations, the risk from an unplanned marine diesel release will remain during operations. As vessels supporting operations will be smaller support vessels compared to the large DP pipelay vessel, the worst-case credible scenario is considered to be no greater than 350 m3. Consequently, and as described above for the construction phase, any impacts to fish, ray and shark populations or viability are not expected.

9.6.2.6 Plankton

Construction and Operations

<u>Unplanned marine diesel release</u>

The only aspect that has the potential to significantly impact plankton communities is an unplanned release of marine diesel during bunkering or a vessel collision, particularly by any entrained fractions of hydrocarbon. Toxic effects from exposure to entrained hydrocarbons may cause impacts such as blocked filter feeding organs and impacts resulting from ingestion of hydrocarbons. Based on the worst-case credible release scenarios, entrained hydrocarbons are expected to be highly localised around the release location and will weather and evaporate rapidly. Given the high productivity of planktonic communities and the nature and scale of the credible spill, these impacts are expected to be highly localised to the release location and temporary in nature and are not expected to result in significant impacts.

As described in **Section 9.5.2.1,** Project oil spill modelling will be completed to inform spill preparedness and response arrangements.

9.6.2.7 Seabirds and migratory shorebirds

Construction and Operations

Unplanned marine diesel release

The only aspect that has the potential to significantly impact seabirds is an unplanned release of marine diesel during bunkering or a vessel collision.

Seabirds and migratory shorebirds are particularly vulnerable to contact with floating hydrocarbons, which may mat feathers. This may lead to hypothermia from loss of insulation and ingestion of hydrocarbons when preening to remove hydrocarbons; both impacts may result in mortality (Hassan and Javed, 2011). Seabirds generally do not exhibit avoidance behaviour to floating hydrocarbons. Physical contact of seabirds with surface slicks is by several exposure pathways, primarily immersion, ingestion and inhalation. Contact with hydrocarbons may result in plumage fouling and hypothermia (loss of thermoregulation), decreased buoyancy and potential to drown, inability to fly or feed, anaemia, pneumonia and irritation of eyes, skin, nasal cavities and mouths (Australian Maritime Safety Authority, 2013b; International Petroleum Industry Environmental Conservation Association, 2004) and result in mortality due to oiling of feathers or the ingestion of hydrocarbons. Longer term exposure effects that may potentially impact seabird populations include a loss of reproductive success (loss of breeding adults) and malformation of eggs or chicks (Australian Maritime Safety Authority, 2013b).

A hydrocarbon spill may result in surface slicks above impact thresholds in foraging habitat for seabirds. Given the nature and scale of the credible hydrocarbon spill, the potential for impacts to birds is expected to be temporary (hours to days) and restricted to the small areas near the spill location. Stranded hydrocarbons may come into contact with wading shorebirds, potentially resulting in oiling. As seabirds nest above the high water mark, direct contact to nests, eggs or hatchlings by stranded hydrocarbons is not expected to occur. Based on this, the rapid weathering of MDO and the smaller worst-case spill scenario from smaller vessels that will operate in areas closer to shorebird habitat, significant impacts are not expected.

As described in **Section 9.5.2.1**, Project oil spill modelling will be completed to inform spill preparedness and response arrangements including the need for oiled wildlife response.

Operations

Unplanned marine diesel release

As vessel-based activities are part of operations, the risk from an unplanned marine diesel release will remain during operations. As vessels supporting operations will be smaller support vessels compared to the large DP pipelay vessel, the worst-case credible scenario is considered to be no greater than 350 m3. Consequently, and as described above for the construction phase, any impacts to seabirds and migratory shorebird populations or viability are not expected.

Dry gas release from pipeline rupture during operations

As presented in **Section 9.5.2.3** above, a worst-case pipeline rupture during operations would result in a release of dry gas to the environment which would move towards the surface forming a large plume in the water column and dispersing into the atmosphere. Consequently, the gas cloud may result in impacts to air-breathing fauna, such as seabirds and migratory shorebirds, with the worst-case outcome being animals breathing in the immediate vicinity of the release being asphyxiated, potentially resulting in mortality. Given the dispersion of gas into the atmosphere, this potential effect would be highly localised to the release location.

When considering the controls and mitigations presented in **Section 9.5.2.3** above, the risk of a dry gas release from a pipeline rupture during operations is considered to be low.

9.6.2.8 Ecological function and processes

Unplanned introduction of IMS

The potential for a significant impact to ecological function and processes, and integrity of marine ecosystems comes from an unplanned introduction of an IMS. As described above in **Section 9.5.2.2**.

9.6.3 Potential cumulative impacts

Given the proposed location, the narrow linear pipeline corridor (i.e., notional 50-m pipeline disturbance footprint within an existing pipeline corridor), proximity of the spoil disposal ground to an existing and much larger spoil ground and based on knowledge gained from planning and executing similar pipeline projects in this location, potential impacts to intertidal and benthic habitats and marine fauna that may occur will be localised and temporary in nature. As a result, it is unlikely that these impacts could accumulate to result in a significant impact to marine ecosystems in the Darwin Harbour and associated offshore NT waters.

Should other proponents be considering similar activities over similar locations and time frames to Project activities, Santos will work with other proponents to consider the potential for cumulative impacts and mitigate where reasonably practicable.

9.6.4 Environmental mitigation and management

The following measures will be implemented to mitigate and manage the potential environmental impacts. A number of these mitigation measures are already implemented for the existing DLNG facility operations, as per the DLNG OEMP (DLNG/HSE/PLN/001) which Santos has been operating since 2006. Consequently, there is demonstrated experience mitigating and managing environmental impacts and risks from Project activities.

Avoid

+ Given the seabed characteristics and need for intervention to install, stabilise and protect the Project pipeline, some impacts to the marine environmental quality, no matter how temporary or localised, are unavoidable. However, they will be mitigated and managed; and
+ Only marine diesel oil (MDO) or marine gas oil (MGO) will be used, thereby avoiding the risk of more environmentally persistent heavier fuel types, such as intermediate fuel oil (IFO) or heavy fuel oil (HFO), from being released to the marine environment.

Mitigate

+ Pre-lay survey will be completed to ensure the Project pipeline is laid along the proposed route and avoids environmental sensitivities where safe to do so;
+ Dynamically positioned (DP) pipelay vessel will be used in deeper water sections to eliminate seabed disturbance from an anchor spread; and

Manage

+ A Construction Environmental Management Plan (CEMP) will be developed to detail how construction will be undertaken and how potential impacts and risks will be managed, including potential impacts from underwater noise if sheet piling is required;
+ A Trenching, Spoil Disposal Management and Monitoring Plan (TSDMMP), including a Waste Discharge Licence (WDL), will be developed to include controls for trenching activities required along the Project pipeline and shore crossing;
+ Implement a marine monitoring program to monitor water quality (near and distant from trenching activities; and if data gaps exist from existing water quality monitoring programs) which will be used to inform ongoing management of Project activities;
+ An OEMP will be developed and will identify ongoing environmental management measures and oil spill response measures in the event of a hydrocarbon spill from a vessel or the pipeline. The primary spill response will be to monitor and evaluate, given the rapid weathering characteristics of MDO and MGO used in vessel operations and with the pipeline transporting dry gas only. Santos will be prepared to implement other spill response arrangements such as shoreline protection, shoreline clean-up and oiled wildlife response in the unlikely event this was required; and
+ Santos will continue to implement its Stakeholder Engagement Plan to ensure that relevant stakeholders and members of the community remain informed about Project activities including the potential for temporary impacts to commercial and recreational fishing;

9.6.5 Conclusion of residual risk

Following the implementation of the mitigation and management measures above and considering the nature of the receiving environment (e.g., pipeline duplication within a disturbed pipeline corridor and industrial precinct; with a spoil ground adjacent to an existing facility; vessels operating in a major Northern Australian port), the environmental consequence to marine ecosystems is considered to be 'Minor' and residual risks 'Low' (refer to **Appendix I** for Environmental Risk Framework).

9.6.6 Predicted Outcome and Conclusions

The Project is not inconsistent with the above listed government policies and guidelines.

Stakeholders have raised concerns regarding potential impacts from trenching-related activities, including impacts to marine fauna and habitat and water quality. Santos acknowledges these issues and is committed to ongoing and transparent communication with identified stakeholders and members of the Darwin community. To this end, Santos will continue to implement and update a Project SEP (**Appendix C**) and make its environmental management plans and monitoring programs publicly available.

Considering the environmental assessment as supported by publicly available and extensive monitoring data, and with the application of management and monitoring commits, it is concluded that environmental impacts and risks to the marine ecosystem are acceptable and manageable, and that the NT EPA objective for this factor will be met.

10 Matters of National Environmental Significance

Under the EPBC Act, an action will require approval from the Commonwealth Minister if the action has, will have, or is likely to have, a significant impact on a Matter of National Environmental Significance (MNES). A search of the Commonwealth Protected Matters Search Tool (PMST) (including a 5-km buffer) was undertaken for the preferred Project pipeline (northern route). A summary of the results of the PMST are provided in **Table 10-1**. The full PMST results are provided in **Appendix E.**

Table 10-1 Summary of relevant MNES

Matters of National Environmental Significance	Relevant	Description
World heritage properties	N	There are no world heritage properties within close proximity to the Project Area
National heritage places	N	There are no national heritage places within close proximity to the Project Area
Wetlands of International Importance (Ramsar)	N	There are no wetlands of international importance/Ramsar wetlands within close proximity to the Project Area
Great Barrier Reef Marine Park	N	Not applicable
Commonwealth marine areas	N	Exclusive Economic Zone and Territorial Sea (not applicable)
Listed threatened ecological communities	N	There are no threatened ecological communities within close proximity to the Project Area
Listed threatened species	Y	41 (birds - 13, mammals - 14, reptiles - 7, sharks - 7) + Critically Endangered - 4 + Endangered – 12 + Vulnerable - 25
Listed migratory species	Y	74 (migratory marine birds - 6, migratory marine species – 28, migratory terrestrial species - 40) + Critically Endangered - 3 + Endangered – 6 + Vulnerable - 12

10.1 Likelihood of occurrence

A likelihood of occurrence assessment was completed on species identified from the PMST desktop assessment, consisting of listed threatened species, migratory species, marine species, whales and other cetaceans (**Appendix H**). This likelihood of occurrence assessment was based on known records of the species within a 5 km radius of the Project pipeline (sourced from publicly available information and previous studies of the area) and the species habitat requirements with respect to habitat features present within the vicinity of the Project Area.

The criteria applied to define the likelihood of occurrence for terrestrial fauna is:

+ **Unlikely**: the Project Area is not within the species known distribution; and/or suitable habitat is not present within the Project.
+ **Potential**: the Project Area is within the species known distribution, but the species has not been recorded within 5 km of the Project; and the Project Area contains suitable habitat for the species.
+ **Likely**: the species has been recorded within 5 km of the Project in the past 10 years; and the Project Area contains suitable habitat for the species.
+ **Known to occur**: the species has been recorded (directly by commissioned surveys or from database records) within the Project Area in the past 10 years.

The criteria applied to define the likelihood of occurrence for marine fauna is:

+ **Unlikely**: the species has not been recorded within Darwin Harbour or surrounding waters; and/or its current known distribution of the species does not encompass Darwin Harbour; and/or suitable habitat is generally lacking from the Project Area.
+ **Potential**: the species has not been recorded within Darwin Harbour or surrounding waters, although species' distribution incorporates Darwin Harbour; and potentially suitable habitat occurs in the Project Area.
+ **Likely**: the species has been recorded within Darwin Harbour or surrounding waters in the past 10 years; and suitable habitat is present within the Project Area.
+ **Known to occur**: the species has been recorded within the Project Area in the past 10 years.

The species taken through to the Significant Impact Guidelines 1.1 Self-assessment in **Section 10.4**, are those species that are known to occur or, considered likely to occur, as summarised in **Appendix H**.

10.2 Listed threatened species

10.2.1 Threatened fauna

The PMST search (**Appendix E**) identified 41 listed threatened species as occurring within the Project Area or as potentially occurring within the vicinity of the Project Area (refer to **Section 10.1**). A likelihood of occurrence assessment (refer to **Appendix H**) was completed for all threatened species, based on known species records, as described in **Section 10.1**. The assessment identified two species listed as threatened under the EPBC Act as being likely to occur within or nearby to, the Project Area, as shown in **Table 10-2**. **Table 10-2** provides the EPBC status and the Territory Parks and Wildlife

Conservation Act status for these species, as per the DEPWS NR Maps (DEPWS, 2021a) database and the Darwin Harbour SoCS Factsheet for threatened species records.

Table 10-2 Listed threatened species

Common Name	Scientific Name	EPBC Status	NT Status
Flatback turtle	*Natator depressus*	Vulnerable / Migratory	Vulnerable / Migratory
Olive Ridley turtle	*Lepidochelys olivacea*	Endangered / Migratory	Endangered / Migratory

10.3 Listed migratory species

The PMST search (**Appendix E**) identified 74 listed migratory species as occurring within the Project Area or as potentially occurring within the vicinity of the Project Area (refer to **Section 10.1**). A likelihood of occurrence assessment (refer to **Appendix H**) was completed for all migratory species, based on known species records, as described in **Section 10.1**. The assessment identified seven species listed as migratory under the EPBC Act as being likely to occur within or nearby to, the Project Area, as shown in **Table 10-3. Table 10-3** provides the EPBC status and the Territory Parks and Wildlife Conservation Act status for these species, as per the DEPWS NR Maps (DEPWS, 2021a) database and the Darwin Harbour SoCS Factsheet for threatened species records.

As per the likelihood of occurrence assessment provided in **Appendix H**, a number of migratory birds have the potential to occur within the Project Area, however these would likely be transiting to areas either side of the Project Area which contain suitable habitat. Given the shore crossing is located within the existing DLNG disturbance envelope and there is no suitable habitat directly within the Project Area, migratory birds have therefore not been considered further in this assessment.

Table 10-3 Listed migratory species

Common Name	Scientific Name	EPBC Status	NT Status
Flatback turtle	*Natator depressus*	Vulnerable / Migratory	Vulnerable / Migratory
Olive Ridley turtle	*Lepidochelys olivacea*	Endangered / Migratory	Endangered / Migratory
Australian Snubfin dolphin	*Orcaella heinsohni*	Migratory	Migratory
Dugong	*Dugong dugon*	Migratory	Migratory
Indo-Pacific Humpback dolphin	*Sousa chinensis*	Migratory	Migratory
Salt-water crocodile	*Crocodylus porosus*	Migratory	Migratory
Spotted Bottlenose dolphin	*Tursiops aduncus*	Migratory	Migratory

10.4 Significant Impact Guidelines 1.1 Self-assessment

An assessment against the Significant Impact Guidelines 1.1 (DoE, 2013) was undertaken to identify whether the Project is likely to have a significant impact upon any MNES that may be present within the Project Area. **Table 10-4** presents a self-assessment against the significant impact criteria for those MNES identified as potentially occurring within or nearby to the Project, as summarised in **Table 10-4**.

Table 10-4 Significant impact guidelines 1.1 MNES - assessment criteria

MNES	Significant Impact Criteria	Is the Proposed Action Likely to Trigger the Criteria?	Description of MNES
Threatened species and ecological communities			
Critically endangered and endangered species	Lead to a long-term decrease in the size of a population	N	The Olive Ridley turtle is the only critically endangered or endangered species that has a likelihood of occurring within or nearby to the Project Area (**Appendix H**). The Olive Ridley turtle has a biologically important area (BIA) of internesting habitat near the Project Area (i.e. around the Tiwi Islands and south of Darwin Harbour), as shown in **Figure 7-10**. Potential impacts to the Olive Ridley turtle may include injury or mortality from vessel collision and/or changes in behaviour such as avoidance of the area due to localised increases in underwater noise as a result of trenching activities, and localised increases in light emissions. However, given the large number of vessels already utilising Darwin Harbour regularly, the increase in vessel traffic from the Project is considered unlikely to result in a greater risk of vessel collision with this species than the current environment. Underwater noise emissions have the potential to affect marine fauna, including the Olive Ridley turtle, as described in **Section 9.6.2.** Construction activities will contribute to the underwater noise within the area. However, given the narrow operating area for the Project, it is considered that mobile animals such as turtles will be able to move away freely before any physical or behavioural changes occur. Impacts would likely only be temporary avoidance of the area. Marine turtles are sensitive to artificial light during nesting and hatching, as described in **Section 9.6.2**. Given the Project does not

MNES	Significant Impact Criteria	Is the Proposed Action Likely to Trigger the Criteria?	Description of MNES
			intersect directly with any critical breeding or nesting habitat for the Olive Ridley turtle and they are only considered to be transiting through the area, disturbance from artificial light is considered unlikely. Operation of the Project is unlikely to generate noise of any significance to marine fauna. Furthermore, the use of operations vessels would be minimal and unlikely to increase the risk of collision with turtles than the current environment. Given the location of critical habitat and nesting areas for the Olive Ridley turtle outside of the Project Area and the successful implementation of management measures for similar projects in the area (i.e. Ichthys GEP and Bayu-Undan to Darwin pipeline), it is considered that potential impacts can be effectively minimised and if occur, would be short term and highly localised. The Project is unlikely to lead to a long-term decrease in the size of a population of the Olive Ridley turtle.
	Reduce the area of occupancy of the species	N	Based on the justification provided above, the Project is unlikely to reduce the area of occupancy of the Olive Ridley turtle.
	Fragment an existing population into two or more populations	N	Based on the justification provided above, the Project is unlikely to fragment an existing population of Olive Ridley turtles into two or more populations.
	Adversely affect habitat critical to the survival of a species	N	The Project does not intersect with any habitat critical to the survival of the Olive Ridley turtle and therefore it is considered unlikely that the Project would adversely affect habitat critical to the survival of the species.

MNES	Significant Impact Criteria	Is the Proposed Action Likely to Trigger the Criteria?	Description of MNES
	Disrupt the breeding cycle of a population	N	Based on the justification provided above, the Project is unlikely to disrupt the breeding cycle of a population of Olive Ridley turtles that may occur nearby to the Project Area.
	Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	N	Based on the justification provided above, the Project are unlikely to modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the Olive Ridley turtle is likely to decline.
	Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat	N	Santos will implement measures to reduce the risk of introduced species, including abiding by the Australian Ballast Water Requirement 2017 (Commonwealth of Australia (DAWR), 2017) and appropriate biofouling and quarantine procedures for vessels. It is therefore unlikely that the Project would result in invasive species that are harmful to the Olive Ridley turtle becoming established in the species' habitat.
	Introduce disease that may cause the species to decline	N	Based on the justification provided above, the Project is unlikely to introduce disease that may cause the Olive Ridley turtle species to decline.
	Interfere with the recovery of the species	N	Based on the justification provided above, the Project is unlikely to interfere with the recovery of the Olive Ridley turtle.

MNES	Significant Impact Criteria	Is the Proposed Action Likely to Trigger the Criteria?	Description of MNES
Vulnerable species	Lead to a long-term decrease in the size of an important population of a species	N	The Flatback turtle is the only vulnerable species that has a likelihood of occurring within or nearby to the Project Area (**Appendix H**). The Flatback turtle has a BIA of internesting habitat and habitat critical to the survival of the species intersecting the Project Area as shown in **Figure 7-9**. Potential impacts to the Flatback turtle may include injury or mortality from vessel collision and/or changes in behaviour such as avoidance of the area due to localised increases in underwater noise as a result of trenching activities, localised increases in light emissions. However, given the large number of vessels already utilising Darwin Harbour regularly, the increase in vessel traffic from the Project is considered unlikely to result in a greater risk of vessel collision with this species than the current environment. Underwater noise emissions have the potential to affect marine fauna, including the Flatback turtle, as described in **Section 9.6.2**. Construction activities will contribute to the underwater noise within the area and these impacts have been detailed in **Section 9.6.2**. However, given the narrow operating area for the Project, it is considered that mobile animals such as turtles will be able to move away freely before any physical or behavioural changes occur. Impacts would likely only be temporary avoidance of the area. Marine turtles are sensitive to artificial light during nesting and hatching, however, the studies undertaken for the Ichthys project found that the mangroves and mudflats throughout the shoreline of Darwin Harbour do not provide suitable beach habitat for nesting turtles (INPEX Browse, Ltd, 2010a) (refer to **Section 9.6.2**). It is therefore not expected

MNES	Significant Impact Criteria	Is the Proposed Action Likely to Trigger the Criteria?	Description of MNES
			that artificial light generated by the Project would cause an adverse impact on Flatback turtles. Operation of the Project is unlikely to generate noise of any significance to marine fauna. Furthermore, the use of operations vessels would be minimal and unlikely to increase the risk of collision with turtles than the current environment (refer to **Section 9.6.2**). The Ichthys EIS (INPEX Browse, Ltd 2010a) concluded that the shorelines of Darwin Harbour do not to provide suitable nesting habitat for any species of turtle that may occur in the area, as per the advice of Dr Mick Guinea (Marine Biologist, Charles Darwin University, pers comm. September 2008). Given this and the successful implementation of management measures for similar projects in the area (e.g. Ichthys and Bayu-Undan to Darwin pipeline) in minimising adverse impacts to marine turtles, the Project is considered unlikely to lead to a long-term decrease in the size of a population of the Flatback turtle species.
	Reduce the area of occupancy of an important population	N	Based on the justification provided above, the Project is unlikely to reduce the area of occupancy of an important population of Flatback turtles.
	Fragment an existing important population into two or more populations	N	Based on the justification provided above, the Project is unlikely to fragment an existing important population of Flatback turtles into two or more populations.

MNES	Significant Impact Criteria	Is the Proposed Action Likely to Trigger the Criteria?	Description of MNES
	Adversely affect habitat critical to the survival of a species	N	The Project intersects a small portion of the habitat critical to the survival of the Flatback turtle (**Figure 7-9**). However, based on the justification provided above that the shorelines of Darwin Harbour do not to provide suitable nesting habitat for any species of turtle that may occur in the area, it is considered unlikely that the Project would adversely affect habitat critical to the survival of the species.
	Disrupt the breeding cycle of an important population	N	Based on the justification provided above, the Project is unlikely to disrupt the breeding cycle of an important population of Flatback turtle.
	Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	N	Based on the justification provided above, the Project are unlikely to modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the Flatback turtle species is likely to decline.
	Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	N	Santos will implement measures to reduce the risk of introduced species, including abiding by the Australian Ballast Water Requirement 2017 (Commonwealth of Australia (DAWR), 2017) and appropriate biofouling and quarantine procedures for vessels. It is therefore unlikely that the Project would result in invasive species that are harmful to Flatback turtles becoming established in key areas of Flatback turtle habitat.

MNES	Significant Impact Criteria	Is the Proposed Action Likely to Trigger the Criteria?	Description of MNES
	Introduce disease that may cause the species to decline	N	Based on the justification provided above, the Project is unlikely to introduce disease that may cause the Flatback turtle species to decline.
	Interfere substantially with the recovery of the species	N	Based on the justification provided above, the Project is unlikely to interfere with the recovery of the Flatback turtle species.
Migratory species			
Migratory marine, terrestrial and wetland	Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species	N	The likelihood of occurrence assessment (**Appendix H**) identified five migratory marine species that have a likelihood of occurring within or nearby to the Project Area, including three species of inshore dolphins, as well as the dugong and Saltwater crocodile. Impacts to these species are discussed below and detailed further in **Section 9.6.2**. The Project intersects BIAs for the Australian Snubfin dolphin, Indo-Pacific Humpback dolphin and the Indo-Pacific/Spotted Bottlenose dolphin, known to undergo breeding, calving and/or foraging within Darwin Harbour (refer to **Figure 7-11** to **Figure 7-13** respectively). Potential impacts to inshore dolphins may include injury or mortality from vessel collision and/or changes in behaviour such as avoidance of the area due to localised increases in underwater noise as a result of trenching activities, localised increases in light emissions. Collisions between these dolphin species and vessels is infrequent due to the mobility of smaller cetaceans which allows them to easily avoid vessels (Santos, 2021). In addition, given existing commercial shipping and fishing activities occur in the area, it is considered unlikely that vessels from the project would increase the risk of impact to these species.

MNES	Significant Impact Criteria	Is the Proposed Action Likely to Trigger the Criteria?	Description of MNES
			There is the potential for trenching to disrupt these dolphins when foraging in Darwin Harbour however, studies undertaken for Ichthys found that these dolphins are commonly observed foraging in turbid waters (INPEX Browse Ltd, 2010a). Given the mobility of these migratory species and their ability to avoid areas of noise that are not satisfactory or may cause them harm, it is considered that underwater noise emissions associated with the Project are unlikely to significantly affect these migratory species. Impacts would likely be only temporary avoidance of the area. Artificial light is not considered likely to have a negative effect on foraging dolphins or dugongs. In addition, given Darwin Harbour is heavily industrialised with many other developments operating along the shores, it is considered unlikely that artificial light from the Project would adversely affect dolphins and dugongs with no evidence of them currently being affected by light emissions from current developments (INPEX Browse Ltd, 2010a). Dugongs are known to occur in Darwin Harbour where suitable habitat (e.g., seagrass meadows) occur (ConocoPhillips,2018, 2019a). Dugongs are likely to respond in a similar way to dolphins and avoid the area during trenching activities and therefore physical injury from underwater noise is not expected (INPEX Browse Ltd, 2010a). As with dolphins, there is no evidence to support dugongs being negatively affected by artificial light within Darwin Harbour (INPEX Browse Ltd, 2010a).

MNES	Significant Impact Criteria	Is the Proposed Action Likely to Trigger the Criteria?	Description of MNES
			INPEX Browse Ltd concluded that Saltwater crocodiles (INPEX Browse Ltd, 2010a) crocodiles are likely to be accustomed to turbid conditions as they regularly frequent shallow coastal areas and mangroves and are not expected to be impacted by trenching activities associated with the Project. As with the other migratory species, underwater noise emissions associated with the Project as described in **Section 9.6.2**, are unlikely to result in a significant impact to crocodiles as it is considered that they would move away from the area of noise temporarily. Given the above, the Project is unlikely to substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for inshore dolphins, dugongs, Saltwater crocodiles or migratory birds.
	Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species	N	Santos will implement measures to reduce the risk of introduced species, including abiding by the Australian Ballast Water Requirement 2017 (Commonwealth of Australia (DAWR), 2017) and appropriate biofouling and quarantine procedures for vessels. It is therefore unlikely that the Project would result in invasive species that are harmful to a migratory species becoming established in the migratory species' habitat. The only area considered to be 'important' habitat for migratory species would be Darwin Harbour which is a BIA for the Australian Snubfin dolphin, Indo-Pacific Humpback dolphin and the Indo-Pacific/Spotted Bottlenose dolphin, known to undergo breeding, calving and/or foraging within Darwin Harbour.

MNES	Significant Impact Criteria	Is the Proposed Action Likely to Trigger the Criteria?	Description of MNES
	Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species	N	Based on the justification provided above, the Project is unlikely to disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

11 Consideration of Ecologically Sustainable Development

The EP Act is clear in its purpose of promoting the ecologically sustainable development of the Northern Territory. The EP Act defines ecologically sustainable development as 'development that improves the total quality of human life, both now and in the future, in a way that:

+ Maintains the ecological processes on which all life depends; and
+ Recognises the need for development to be equitable between current and future generations'.

The Project has been considered against the principles of ecologically sustainable development, as set out in Part 2 Division 1 of the EP Act (refer to **Table 11-1**).

Table 11-1 Principles of ecologically sustainable development

Principle name	Principle	Phase	Theme	Environmental Factors Considered	How ESD principles have been considered
Decision making Principle	Decision-making processes should effectively integrate both long-term and short-term environmental and equitable (unbiased) considerations.	Planning, construction, operations and decommissioning	All	Marine Environmental Quality Marine Ecosystems Community and Economy	As part of the planning and design Santos has considered short-term and long-term economic, environmental, social and equitable issues, with the strategic objective to create an opportunity for a positive contribution. Costs through temporary environmental disturbance and increased marine traffic within the Darwin Harbour have been weighed against short-term (during planning and construction) and long-term (during operations) local economic benefits and design to minimise impacts. The Project provides an opportunity for re-purposing the Bayu-Undan to Darwin pipeline by transferring carbon dioxide into the Bayu-Undan underground geological formations for permanent storage. Carbon Capture and Storage (CCS) can help to reduce Santos' (Northern Territory) GHG emissions.
	Decision-making process should provide for community involvement in	Approvals	People	Community and Economy	Santos has progressed early engagement with key stakeholders, including but not limited to: + Northern Territory regulators / agencies. + Darwin Ports and representative bodies.

Principle name	Principle	Phase	Theme	Environmental Factors Considered	How ESD principles have been considered
	relation to decisions and actions that affect the community				+ Indigenous groups and representative bodies. + Local environmental groups. + Fishers and representative bodies. + Other industry / operators. Santos aims to actively consult and engage with all relevant stakeholders throughout the approvals process in the decision-making process for the Project. The NT environmental approvals process provides statutory time frames for any member of the community to comment on the Project. Santos will continue to implement a Project Stakeholder Engagement Plan.
Precautionary Principle	If there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to	Approvals	Sea	Marine Environmental Quality Marine Ecosystems	The key risks and impacts of the Project are associated with marine environmental quality and marine ecosystems. During the options analysis potential impacts to the physical and biological marine environment (including fauna and flora) were compared to determine the preferred option to minimise impacts. The key risks and impacts are well understood and have been successfully managed for similar projects (e.g. Bayu-Undan to Darwin pipeline and Ichthys pipeline). The experience and monitoring outcomes from these projects were drawn upon

Principle name	Principle	Phase	Theme	Environmental Factors Considered	How ESD principles have been considered
	prevent environmental degradation				to support the Project options analysis and environmental approvals. Where gaps within the publicly available information were found, additional investigations have been, and will be, undertaken to support a complete understanding of the Project risks and impacts. The Project is therefore unlikely to involve threats of serious or irreversible environmental damage.
	Decision-making should be guided by: a careful evaluation to avoid serious or irreversible damage to the environment wherever practicable; and an assessment of the risk-weighted consequences of various options.	Approvals	All	Where relevant	As per above. The concept studies undertaken for the Project were informed by detailed evaluation of route selection options, so as to identify the best practical option that minimise risks and impacts. This is described in detail in **Section 5**. An assessment of significance of potential impacts to the NT EPA's factors and objectives in relation to the Project was undertaken. The framework applied to inform the impact assessment and determine residual risk for each of the NT EPA factors included: + Pre-referral screening of the Project as per the NT EPA pre-referral screening tool; + Undertaking a preliminary risk analysis integrating Santos' risk approach with

Principle name	Principle	Phase	Theme	Environmental Factors Considered	How ESD principles have been considered
					enhanced pre-determined consequence descriptors relevant to the Project; + Application of suitable mitigation and management measures to reduce the risk to EPA factors to acceptable level; and + Determining the residual level of risk following the application of mitigation and management measures for each of the EPA factors.
Principle of evidence-based decision-making	Decisions should be based on the best available evidence in the circumstances that is relevant and reliable.	Approvals	All	Where relevant	This NT referral supporting information draws upon existing publicly available data and learnings and experience from other comparable projects and activities to inform the potential impacts of the Project and develop suitable mitigation and management measures. This existing information has also been used to guide selection of the preferred pipeline corridor and route option within Darwin Harbour to minimise disturbance to the existing environmental, social and heritage values.
Principle of intergenerational and intragenerational equity	The present generation should ensure that the health, diversity and productivity of	Operations	People	Communities and economy	Santos is committed to ensuring the Project will not adversely impact on future generations and instead aims to provide opportunities for future generations. The Project would provide an opportunity for Barossa and other third-party users to bring gas

Principle name	Principle	Phase	Theme	Environmental Factors Considered	How ESD principles have been considered
	the environment is maintained or enhanced for the benefit of present and future generations.				to DLNG to support ongoing DLNG operation to meet energy demand and continue to support local jobs and economy. A balance is required between meeting the short term needs of the current generation, while taking action through initiatives such as the International Paris Agreement to preserve the environment for the benefit of future generations. The Project presents an opportunity to achieve emissions reduction targets consistent with the NT EPA objective. Specifically, the development of the Project preserves the Bayu-Undan to Darwin pipeline for life extension and/or re-purposing opportunities. The current re-purposing opportunity being investigated is the transfer of carbon dioxide from DLNG to Bayu-Undan reservoir for Carbon Capture and Storage (CCS). Re-purposing of the Bayu-Undan facilities represents one of a portfolio of options being explored by Santos to achieve our net zero emissions by 2040 target. In addition, the contribution of gas to DLNG as part of the Project will be within the existing capacity licence of DLNG and the Project will therefore not be increasing the production of

Principle name	Principle	Phase	Theme	Environmental Factors Considered	How ESD principles have been considered
					gas or GHG emissions over what is already approved for the DLNG facility.
Principle of sustainable use	Natural resources should be used in a manner that is sustainable, prudent, rational, wise and appropriate	Approvals, construction and operations	All	Where relevant	Santos is committed to using natural resources sustainably. The underlying premise of the Project is to utilise pre-existing corridors and infrastructure to the maximum extent possible. The spoil ground has been selected to be directly adjacent to the Ichthys spoil ground. The Project proposes to use borrow material as backfill for pipeline stabilisation from a borrow ground in offshore NT waters. The onshore component of the Project is localised to the shore crossing and connection into DLNG, following the existing corridor and within a pre-existing industrial land use, separated from sensitive land uses.
Principle of conservation of biological diversity and ecological integrity	Biological diversity and ecological integrity should be conserved and maintained.	Approvals, construction and operations	All	Where relevant	Project is effectively a pipeline duplication with the offshore and nearshore components following the Bayu-Undan to Darwin pipeline and the Ichthys pipeline corridor. The onshore section of the Project is contained wholly within the existing DLNG disturbance envelope. This consideration and commitment to the Project alignment has minimised the potential risks and impacts ensuring the protection and

Principle name	Principle	Phase	Theme	Environmental Factors Considered	How ESD principles have been considered
					conservation of biological diversity and integrity.
Principle of improved valuation, pricing and incentive mechanisms	Environmental factors should be included in the valuation of assets and services.	Approvals, construction and operations	All	Where relevant	The Project supports the extension of the DLNG facility, creates a new asset and preserves the Bayu-Undan to Darwin pipeline for potential future re-use opportunities including CCS. The Project will positively contribute to the Northern Territory economy during construction and ongoing operations phases, without causing significant environmental or social impacts.
	Persons who generate pollution and waste should bear the cost of containment, avoidance and abatement.	Approvals, construction and operations	All	Where relevant	As a long-term operator in Northern Australia, Santos has a well-established system for the management of wastes and discharges and assumes full responsibility for these aspects. The generation of some waste is unavoidable, however, Santos has committed to minimising waste where possible and recycling, reusing and treating waste appropriately. The costs for all waste management, disposal and monitoring (where required) will be borne by Santos.
	Users of goods and services should pay prices based on	Approvals, construction and operations	All	Where relevant	Supply chain management is inherently imbedded into the Santos management system. Santos management system ensures the appropriate selection of vendors and suppliers.

Principle name	Principle	Phase	Theme	Environmental Factors Considered	How ESD principles have been considered
	the full life cycle costs of providing the goods and services, including costs relating to the use of natural resources and the ultimate disposal of wastes.				Procurement of goods and services through the proposed Project provides the value-based continuity of supply of gas to DLNG, while creating opportunity for CCS.

Principle name	Principle	Phase	Theme	Environmental Factors Considered	How ESD principles have been considered
	Established environmental goals should be pursued in the most cost-effective way by establishing incentive structures, including market mechanisms, which enable persons best placed to maximise benefits or minimise costs to develop solutions and responses to environmental problems.	Approvals, construction and operations	All	Where relevant	The achievement of environmental goals is reflected in the core strategic imperative of the Project. Specifically, to create opportunity for the Bayu-Undan to Darwin pipeline to be re-purposed for CCS. Santos is aiming to plan and execute the Project as efficiently as possible in order to eliminate waste and reduce environmental and social impacts.

12 Forward Management and Conclusions

12.1 Forward management

12.1.1 Additional studies

Santos proposes to complete a small number of technical studies to inform the management framework described below. These studies relate to:

+ **Sediment dispersion modelling**: to confirm the likely spatial and temporal extent of suspended sediments and sedimentation from construction activities to inform the marine environmental monitoring program. The modelling will be undertaken once water column and sediment sampling laboratory results from a recent Project environmental baseline survey become available, and on completion of detailed engineering studies that are refining estimated trenching, spoil disposal and borrow material quantities.
+ **Spill modelling (from vessels):** including modelling the fate and effect of unplanned and accidental marine-related hydrocarbon spills during construction activities to inform spill preparedness and response arrangements.
+ **Underwater noise modelling**: to quantify potential noise emissions and exposures from construction activities to inform marine fauna management measures.
+ **Acid sulphate soil assessment**: to assess the presence of ASS prior to disturbance, a survey will be conducted to test soils within the shore crossing location. Where ASS is detected, this data will be used to inform an ASSMP.

12.1.2 Environmental management plans

As previously discussed, the energy sector has a history of successfully managing major construction projects in Darwin Harbour. The significant body of knowledge available together with the established effectiveness of previously implemented management measures provides confidence that the Project can be delivered without significant environmental impact.

Santos commits to implementing a range of construction and operations environmental management plans to ensure impacts and risks to the receiving environment are acceptable and remain as low as reasonably practicable. A marine environmental monitoring program will be implemented to validate the environment assessment, specific to construction activities. The environmental management plans and monitoring results will be publicly available. A summary of these plans and monitoring approach is detailed below.

12.1.2.1 Construction Environmental Management Plan (CEMP)

A CEMP will be developed for the Project and will include specific measures, monitoring and reporting requirements including, but not limited to:

+ Land clearing;
+ Site remediation;
+ Drainage and sediment control;
+ Introduced species (weeds, insects, fauna, invasive marine pests) management;

- Chemical management;
- Spill response;
- Waste management;
- Marine fauna management; and
- Dust, noise and artificial light controls.

12.1.2.2 Acid Sulphate Soil Management Plan (ASSMP)

An ASSMP will be developed to manage shore crossing trenching where ASS maybe excavated and require storage, treatment and disposal. The ASSMP will be informed by site-specific and detailed ASS assessment, and be prepared by a suitably qualified party.

12.1.2.3 Trenching, Spoil Disposal Management and Monitoring Plan (TSDMMP)

A TSDMMP will be developed to manage trenching activities required for pipeline installation and the disposal of material at the spoil disposal ground. The TSDMMP will detail vessel work schedules, methods and rationale used during the trenching and spoil disposal work, and include an overview of how environmental risks and impacts will be mitigated in accordance with project approvals. The plan will also describe vessel management practices implemented to ensure sediment plumes and other hazards are minimised. It will be informed by dispersion modelling of sediments suspended by the trenching and spoil disposal activities, which will also be used to develop a marine environmental monitoring program to confirm that vessel management practices are effectively protecting the marine environment.

12.1.2.4 Operations Environmental Management Plan (OEMP)

An OEMP will be developed for the Project which will identify the environmental management measures that will be applied to the operations of the Project to avoid and manage identified environmental risks. This will include addressing any specific conditions of approval of the Project, including those required by NOPSEMA under an approved Environment Plan to manage the pipeline within Commonwealth waters. The focus of the OEMP will be on IMR vessels and any pipeline repair activities that may require additional vessels. The OEMP will include an oil spill response plan in the event of a hydrocarbon spill from a vessel or the pipeline. The primary spill response will be to monitor and evaluate, given the rapid weathering characteristics of MDO and MGO used in vessel operations and with the pipeline transporting dry gas only. Santos will be prepared to implement other spill response arrangements such as shoreline protection, shoreline clean-up and oiled wildlife response in the unlikely event this was required.

Management of the shore crossing location will be in accordance with the existing DLNG facility operations, as per the DLNG OEMP (DLNG/HSE/PLN/001) which Santos has been operating since 2006.

12.1.2.5 Decommissioning Plan

Decommissioning is discussed in **Section 9.3** and Santos has committed to develop a Project Decommissioning Plan notionally two years before the end of pipeline life.

12.2 Conclusions

Santos' DPD Project will enable natural gas from offshore reservoirs to be exported to the existing DLNG facility with minimal environmental and social impact. Pipeline construction is required by Quarter 1 2023 to meet the Barossa first gas production milestone in early 2025.

Importantly, executing the DPD Project in a timely manner preserves the existing Santos Bayu-Undan to Darwin pipeline for re-purposing opportunities into the future including carrying carbon dioxide for offshore carbon capture and storage (CCS). This opportunity will help Santos meet its net-zero emissions targets.

A robust referral self-assessment has been conducted and has concluded that most impacts during the construction phase would be temporary and localised and can be readily managed with little to no environmental impact. This is supported by the documented success for similar activities of greater scale that have been undertaken previously in this location with strong environmental scrutiny and without significant impacts.

The natural environment and impact potentials are well understood within Darwin Harbour and surrounds, with extensive INPEX Ichthys baseline and monitoring data supplemented by Santos' pipeline environmental data. Therefore the Project has been designed to avoid impacts where possible, and where unavoidable have high-confidence in the nature and low-level effect of interactions on environmental values.

The Project is effectively a pipeline duplication within an existing pipeline route (nominally with 100 m of the Bayu-Undan to Darwin pipeline) and 'brownfields' industrial precinct (i.e. DLNG).

All NT EPA Themes and Factors have been assessed, impacts and risks are readily manageable and EPA objectives will be met. The following three EPA Factors within the 'sea theme', all similar in nature, require focused management:

+ Coastal Processes;
+ Marine Environmental Quality; and
+ Marine Ecosystems.

Santos commits to preparing the following robust, publicly available management plans as conditions of approval, being:

+ Construction Environmental Management Plan;
+ Acid Sulphate Soils Management Plan;
+ Trenching, Spoil Disposal Management and Monitoring Plan;
+ Operations Environmental Management Plan including Spill Response; and
+ Future Decommissioning Management Plan.

In addition to the referral information, Santos will complete a small number of technical studies (sediment dispersion, spill modelling, underwater noise and ASS definition) to inform development of the abovementioned management plans and monitoring program.

The common issues raised by stakeholders were as expected and reflect many of those managed by Santos on an ongoing basis as part of its Northern Australian operations. Santos will continue to implement its SEP to ensure stakeholders remain informed and can engage in direct open dialogue with Santos as the Project advances

13 References

Aboriginal Areas Protection Authority (AAPA), 2020. What is a sacred site? Accessed (4/10/21) https://www.aapant.org.au/sacred-sites/what-sacred-site

Acer, Vaughan. (1993). Draft Environmental Impact Statement. Darwin Port Expansion- East Arm.

AECOM. (2016). Darwin LNG Plant Mangrove Monitoring Program – Review to Inform DLNG EPL Renewal. Report prepared for Santos. Australia Pty Ltd by AECOM Services, Perth, Western Australia, November 2016.

Australian Maritime Safety Authority, 2013. Technical guideline for the preparation of marine pollution contingency plans for marine and coastal facilities. Australian Maritime Safety Authority, Canberra.Australian Marine Safety Authority (AMSA). (2021). Vessel Tracking Data. Available from: https://www.operations.amsa.gov.au/Spatial/DataServices/DigitalData (accessed 23/05/2021).

Aubé, M., Franchomme-Fosse, L., Robert-Staehler, P., and Houle, V. (2005). Light pollution modelling and detection in a heterogeneous environment: Toward a night-time aerosol optical depth retreival method. Proc. SPIE 2005, 5890, 248–256, doi:10.1117/12.615405.

BoM. (2021). Climate Statistics for Australian Locations, Darwin Airport: Site Number 014015. Available at: http://www.bom.gov.au/climate/averages/tables/cw_014015.shtml [Accessed 01/01/2018].

Brocklehurst, P. and Edmeades, B. (1996). The mangrove communities of Darwin Harbour, Technical Report No. R96/7, Department of Lands, Planning and Environment, Darwin.

Brooks, L., Palmer, C., Griffiths, A.D. and Pollock, K. H. (2017). Monitoring Variations in Small Coastal Dolphin Populations: An Example from Darwin, Northern Territory, Australia. Front. Marine Science 4:94. doi: 10.3389/fmars.2017.00094.

Buckee, J., Jimemez, I., Blount, C., Roberts, C., Hughes, M., van Senden, D., Reeds, K., O'Donnell, P., Macbeth, W., Barnes, L., Blewitt, M., Lamb, J., Holloway, C (Cardno)., and Sofie Harrison (INPEX). (2014). Darwin Harbour – A Summary of the Ichthys LNG Project Nearshore Environmental Monitoring Program. Prepared by Cardno for INPEX, Perth, Western Australia.

Bureau of Meteorology (BoM). (2021). Climate statistics for Australia Locations – Darwin Airport. Australian Government. Climate statistics for Australian locations (bom.gov.au).

CDM Smith. (2021). Santos Darwin LNG Mangrove Monitoring 2021 Report 1001139. 26 December 2021.

Chatto, M. (2003). The distribution and status of shorebirds around the coast and coastal wetlands of the Northern Territory. PWCNT, Technical Report 73.

Chatto and Baker. 2008. Flatback turtles

ConocoPhillips. (2018a). Barossa Area Development Offshore Project Proposal. ConocoPhillips. Perth, Western Australia.

ConocoPhillips. (2018b). Darwin LNG Operations Environmental Management Plan (DLNG/HSE/PLN/001) Revision 3, Perth, WA.

ConocoPhillips. (2019a). Darwin LNG Transition Work Program Notice of Intent. ConocoPhillips. Perth, Western Australia.

ConocoPhillips. (2019b). Bayu-Undan Gas Export Pipeline Environment Plan. ConocoPhillips. Perth, Western Australia.

Darwin City Council. (2011). Climate Change Action Plan 2011 - 2020, Darwin.

Darwin Harbour Advisory Committee (DHAC). (2020). Darwin Harbour Strategy, Darwin Harbour Advisory Committee, Darwin.

Darwin Port Authority. (2019). Darwin Port A year in Review 2018-2019. Accessed 01/11/2021 < https://www.darwinport.com.au/sites/default/files/uploads/2019/Year%20in%20Review%202019%20-%20Final%20Web%20Version%20-%202019-11-29.pdf>

Dean, T.A., Stekoll, M.S., Jewett, S.C., Smith, R.O. and Hose, J.E. (1998). Eelgrass (Zostera marina L.) in Prince William Sound, Alaska: Effects of the Exxon Valdez oil spill. Marine Pollution Bulletin, 36: 201-210.

Department of Agriculture, Water and the Environment (DAWE). (2007). National Vegetation Information System (NVIS), mapping tool. Accessed 26/10/2021. < https://www.awe.gov.au/agriculture-land/land/native-vegetation/national-vegetation-information-system>

DAWE. (2021a). EPBC Act Protected Matters Report, generated through Department of Agriculture, Water and the Environment. EPBC Act Protected Matters Reporting Tool, Canberra. Available at: http://www.environment.gov.au/webgis-framework/apps/pmst/pmst.jsf [Accessed 26/10/2021].

DAWE. (2021b). National Conservation Values Atlas. Available at: https://www.environment.gov.au/marine/marine-bioregional-plans/conservation-values-atlas [Accessed 19/05/2021].

DAWE. (2021c). Australian National Shipwreck Database. Australian Government. Available from: https://environment.gov.au/shipwreck/public/maps/shipwreck-map-search-load.do (accessed 24/05/2021).

Department of Communications and the Arts (DCA). (2021). National Map. Available from: https://nationalmap.gov.au/ (accessed 19/05/2021).

Department of Environment and Energy (DoEE). (1993). Directory of Important Wetlands in Australia – Information Sheet: Port Darwin. Available at: http://www.environment.gov.au/cgibin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NT029. [Accessed 29/10/2019].

Department of Environment and Energy (DoEE). (2017a). Recovery Plan for Marine Turtles in Australia, Commonwealth of Australia 2017. Department of Environment and Energy, Canberra, Australian Capital Territory.

(DoEE) 2017b. National Strategy for Reducing Vessel Strike on Cetaceans and other Marine Megafauna. Department of Environment and Energy, Canberra, Australian Capital Territory.

Department of Environment and Natural Resources (DENR). (2006). Threatened species of the Northern Territory: Flatback turtles–Natator depressus. Department of Environment and Natural Resources, Palmerston, Northern Territory.

Department of Environment and Natural Resources (DENR). (2016). NT Saltwater Crocodile (Crocodylus porosus) Wildlife Trade Management Plan. NT Government, Darwin.

Department of Environment and Natural Resources (DENR). (2019). Land Clearing Guidelines. NT Government, Darwin.

Department of Environment and Regulation. (2015a). Identification and investigation of acid sulfate soils and acidic landscapes. Version final. Perth, Western Australia.

Department of Environment and Regulation. (2015b). Treatment and management of soil and water in acid sulfate soil landscapes. Version final. Perth, Western Australia.

Department of Natural Resources, Environment and the Arts (DNREA). (2008). NT Heritage Register. Viewed 26/10/2021, <http://www.nt.gov.au/nreta/heritage/ntregister/>.

Department of Environment, Parks and Water Security (DEPWS). (2019). Darwin Harbour region report cards. Available at: https://depws.nt.gov.au/water/water-management/darwin-harbour/darwin-harbour-region-report-cards/2019-report-cards/darwin-harbour-report-card-2019-zone-1 [Accessed 24/05/2021]

Department of Environment, Parks and Water Security (DEPWS). (2021a). Natural Resources Maps (NR Maps) Northern Territory. Northern Territory Government, Department of Environment and Natural Resources. Available at: https://nrmaps.nt.gov.au/nrmaps.html [Accessed 26/10/2021].

Department of Environment, Parks and Water Security (DEPWS). (2021b). Flora Atlas N.T. Available at: https://nrmaps.nt.gov.au/nrmaps.html [Accessed 26/10/2021].

Department of Environment, Parks and Water Security (DEPWS). (2021c). Fauna Atlas N.T. Available at: https://nrmaps.nt.gov.au/nrmaps.html [Accessed 26/10/2021].

Department of Health. (2011). East Arm Port Expansion Project - Biting Insect Investigation October to December 2010, prepared for URS Australia Pty Ltd, Medical Entomology Centre for Disease Control, February 2011.

Department of Land Resource Management (DLRM). (2012). Threatened species of the Northern Territory: Dwarf sawfish, broad-billed sawfish–Pritis clavata. Department of Land Resource Management, Palmerston, Northern Territory. Available at: https://nt.gov.au/__data/assets/pdf_file/0003/206391/dwarf-sawfish.pdf [Accessed 01/11/2021].

Department of Land Resource Management (DLRM). (2014). Darwin Harbour Water Quality Protection Plan, Department of Land Resource Management, Darwin.

Department of Natural Resources, Environment, the Arts and Sport (NRETAS). (2006a). Threatened species of the Northern Territory: Green turtle–Chelonia mydas. Department of Natural Resources, Environment, the Arts and Sport, Palmerston, Northern Territory.

NRETAS. (2006b). Threatened species of the Northern Territory: Freshwater sawfish–Pritis microdon. Department of Natural Resources, Environment, the Arts and Sport, Palmerston, Northern Territory. Available at: https://nt.gov.au/__data/assets/pdf_file/0005/206393/freshwatersawfish.pdf [Accessed 01/11/2021].

NRETAS. (2006c). Threatened species of the Northern Territory: Green sawfish–Pritis zijsron. Department of Natural Resources, Environment, the Arts and Sport, Palmerston, Northern Territory. Available at: https://nt.gov.au/__data/assets/pdf_file/0006/206394/green-sawfish.pdf [Accessed 01/11/2021].

Department of Natural Resources, Environment, the Arts and Sport (NRETAS). (2010). Water Quality Objectives for the Darwin Harbour Region – Background Document. Department of Natural Resources, Environment, the Arts and Sport, Palmerston, Northern Territory.

Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC). (2012a). Marine bioregional plan for the North Marine Region. Department of Sustainability, Environment, Water, Population and Communities, Commonwealth of Australia, Canberra, Australian Capital Territory.

Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC). (2012b). Species group report card - seabirds. Supporting the marine bioregional plan for the North Marine Region prepared under the Environment Protection and Biodiversity Conservation Act 1999. Department of Sustainability, Environment, Water, Population and Communities, Canberra.

Department of the Environment (DoE). (2013). Significant Impact Guidelines 1.1: Matters of National Environmental Significance. Department of Agriculture, Water and the Environment. Available at: http://www.environment.gov.au/system/files/resources/42f84df4-720b-4dcf-b262-48679a3aba58/files/nes-guidelines_1.pdf [Accessed 26/10/2021].

DoE. (2015a). Conservation management plan for the blue whale: A recovery plan under the Environment Protection and Biodiversity Conservation Act 1999 2015-2025. Department of the Environment, Canberra.

DoE. (2015b). Sawfish and river shark multispecies recovery plan (Recovery Plan). Department of the Environment, Canberra.

Department of the Environment and Energy (DoEE) (2016). Raft National Strategy for Mitigating Vessel Strike of Marine Mega-fauna. Department of the Environment and Energy, Canberra, Australian Capital Territory.

DoEE. (2020). National Light Pollution Guidelines for Wildlife including marine turtles, seabirds and migratory shorebirds. Version 1.0. Commonwealth of Australia 2020.

Duke, N. and Burns, K. (2003). Fate and effects of oil and dispersed oil on mangrove ecosystems in Australia. In: Environmental implications of offshore oil and gas development in Australia. Further research. A compilation of three scientific marine studies. Australian Petroleum Production and Exploration Association, Canberra, Australia Capital Territory.

Ellison, W.T., Southall, B.L., Clark, C.W., and Frankel, A.S. (2012). A New Context-Based Approach to Assess Marine Mammal Behavioral Responses to Anthropogenic Sounds. Conservation Biology 26(1): 21-28. https://doi.org/10.1111/j.1523- 1739.2011.01803.x.

Environment Australia. (2000). Revision of the Interim Biogeographic Regionalisation for Australia (IBRA) and Development of Version 5.1: Summary Report. Environment Australia, Canberra.

Fortune, J. (2006). The grainsize and hevy metal content of sediment in Darwin Habour. Report No. 14/2006D, Aquatic Health Unit, Environmental Protection Agency. Northern Territory Government.

Galaiduk, R., Radford, B., Harries, S., Case M Williams, D., Low Choy., D1 and Smit, N. (2019). Technical Report: Darwin – Bynoe Harbours predictive mapping of benthic communities. Australian Institute of Marine Science, Perth. pp 42.

Gagnon, M.M. and Rawson, C. (2011). Montara well release, Monitoring Study S4A – Assessment of effects on Timor Sea Fish. Curtin University, Perth Western Australia.

Geraci, J.R. and Aubin, D.J. (1988). Synthesis of Effects of Oil on Marine Mammals. Report to U.S. Department of the Interior, Minerals Management Service, Atlantic OCS Region, OCS Study, MMS 88 0049, Battelle Memorial Institute, Ventura, CA, 292 p.

Griffiths, A.D., Groom, R.A., Low Choy, D., Mackarous, K., and Brooks, L. (2020). Darwin Region Coastal Dolphin Monitoring Program: Final Report – 2011 to 2019. Department of Environment, Parks and Water Security, Northern Territory Government.

Hanley, J.R., and Caswell, G.M. (1995). East Arm Port – Stage 1. Water Quality monitoring program. Report on setup phase and baseline data collection. Marine Ecology Technical Report 95/1.

Harewood, A. and Horrocks, J. (2008). Impacts of coastal development on hawksbill hatchling survival and swimming success during the initial offshore migration. Biological Conservation 141, 394–401.

Harper, B.A. (2010). Modelling the Tracy storm surge – implications for storm structure and intensity estimation. Australian Meteorological and Oceanographic Journal, 60, 187-197.

Harrison, L., McGuire, L., Ward, S., Fisher, A., Pavey, C., Fegan, M., and Lynch, B. (2009). An Inventory of Sites of International and National Significance for Biodiversity Values in the Northern Territory. Department of Natural Resources, Environment, the Arts and Sport, Darwin, NT.

Hassan, A., Javed, H. (2011). Effects of Tasman Spirit oil spill on coastal birds at Clifton, Karachi coast, Pakistan. Journal of Animal and Plant Sciences 21, 333–339.

Hazel, J. (2009). Turtles and Vessels: threat evaluation and behavioural studies of green turtles in near-shore foraging grounds. PhD thesis, James Cook University.

Heyward, A., Radford, B., Cappo, M., Wakeford, M., Fisher, R., Colquhoun, J., Case, M., Stowar, M, and Miller, K. (2017). Barossa Environmental Baseline Study, Regional Shoals and Shelf Assessment 2015 Final Report (Final Report). A report for ConocoPhillips Australia Pty Ltd by the Australian Institute of Marine Science, Perth, Western Australia.

Howe, D. (2007). Darwin Acid Sulphate Soil Mapping Project. Department of Natural Resources, Environment and the Arts, Palmerston, NT.

INPEX Browse. (2010a). Ichthys Gas Field Development Project, Ichthys Gas Field Development Project: draft environmental impact statement and the Supplement to the draft environmental impact statement. Report prepared by INPEX Browse, Ltd., Perth, WA.

INPEX Browse, Ltd. (2010b). Ichthys Gas Field Development Project, Draft EIS, Appendix 5, Description and validation of hydrodynamic and wave models for discharges, spills, geomorphology and dredge spoil disposal ground selection.

INPEX Browse, Ltd. (2011). Ichthys Gas Field Development Project: supplement to the draft environmental impact statement. INPEX, Perth, Western Australia.INPEX Browse, Ltd. (2018). Maintenance Dredging and Spoil Disposal Management Plan.

INPEX Browse, Ltd. (2014). Darwin Harbour – A Summary of the Ichthys LNG Project Nearshore Environmental Monitoring Program. Prepared by Cardno for INPEX. Perth, WA.

INPEX Browse. (2018). Maintenance Dredging and Spoil Disposal Management Plan. Plan prepared by INPEX Browse, Ltd., Perth, WA.

International Association for Public Participation (IAP2). (2015). Quality Assurance Standard for Community and Stakeholder Engagement. Available at:

https://www.iap2.org.au/wpcontent/uploads/2019/07/IAP2_Quality_Assurance_Standard_2015.pdf [Accessed 10/11/2021].

International Tanker Owners Pollution Federation. (2011). Effects of oil pollution on the marine environment (Technical Information Paper No. 13). International Tanker Owners Pollution Federation Limited, London.

Jacobs. (2017). Barossa Pipeline Environmental Survey - Water and Sediment Quality Report. Unpublished report prepared for ConocoPhillips.

Jacobs. (2015a). Barossa Environmental Studies - Water Quality Field Survey Report - Summer. Unpublished report prepared for ConocoPhillips, Perth, Western Australia.

Jacobs. (2015b). Barossa Environmental Studies - Sediment Quality and Infauna Field Survey Report - Autumn. Unpublished report prepared for ConocoPhillips, Perth, Western Australia.

JASCO Applied Science (JASCO). (2016). Passive Acoustic Monitoring of Ambient Noise and Marine Mammals – Barossa field: July 2014 to July 2015. JASCO Document 00997, Version 1.0. Report prepared for Jacobs, Perth, Western Australia.

Jensen, A.S. and Silber, G.K. (2003). Large whale ship strike database. U.S. Department of Commerce. National Oceanic and Atmospheric Administration. Technical Memorandum NMFS-OPR-25. Pp.37.

Keesing, J. and Edgar, G. (2016). Understanding the Environmental Risks of Unplanned Discharges – the Australian Context: Benthic Macroinvertebrates. Document No. 1128_01_001/11_Rev1. Prepared for CSIRO, Australia. APPEAWhitePaper_BenthicMacroinverts_Rev1_Final-Submission.pdf Accessed [28/11/2021]

Laist, D.W., Knowlton, A.R., Mead, J.G., Collet, A.S. and Podesta, M. (2001). Collissions between ships and whales. Marine Mammal Science 17(1): 35-75.

Laird, A. (2018). Northern Prawn Fishery Data Summary 2017. NPF Industry Pty Ltd, Australia.

Lilleyman, A., Alley, A., Jackson, D., Gavin O'Brien, G., and Garnett, S. (2018). Distribution and abundance of migratory shorebirds in Darwin Harbour, Northern Territory, Australia. Northern Territory Naturalist (2018) 28: 30–42.

Lohmann, K.J. and Lohmann, C.M.F. (1992). Orientation to Oceanic Waves by Green Turtle Hatchlings. Journal of Experimental Biology 171, 1–13.

Lorne, J.K. and Salmon, M. (2007). Effects of exposure to artificial lighting on orientation of hatchling sea turtles on the beach and in the ocean. Endangered Species Research 3, 23–30.

Lutcavage, M., Lutz, P., Bossart, G., Hudson, D. (1995). Physiologic and clinicopathologic effects of crude oil on loggerhead sea turtles. Archives of Environmental Contamination and Toxicology 28, 417–422.

Makarynksa, D. (2019a). Developing an integrated long-term monitoring program for Darwin Harbour. Water Quality Pilot Project WP1: Neap Tide Trial. Report No. 10/2019S. Department of Environment and Natural Resources, Aquatic health Unit, Water Resources Division.

Makarynksa, D. (2019b). Developing an integrated long-term monitoring program for Darwin Harbour. Water Quality Pilot Project WP2: Intra-annual water quality variability. Report No. 22/2019D. Department of Environment and Natural Resources, Aquatic health Unit, Water Resources Division.

Munksgaard, C. N., Kaestli, M., and Lambrinidis, D. (2020). Development of an Integrated Long-Term Sediment Quality Monitoring Program for Darwin Harbour (Sub-Project SP1a). Background concentrations of metals and metalloids and their relationship to minerology and grainsize distribution in Darwin Harbour sediment FINAL REPORT. Technical Report No. 10/2020. Charles Darwin University, Environmental Chemistry & Microbiology Unit, Darwin, Northern Territory.

National Marine Fisheries Service (NMFS). (2014). Marine Mammals: Interim Sound Threshold Guidance (webpage). National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce.

NMFS. (2018). 2018 Revision to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts. U.S. Department of Commerce, NOAA. NOAA Technical Memorandum NMFS-OPR-59. 167 p. https://www.fisheries.noaa.gov/webdam/download/75962998.

National Pollutant Inventory. (1999). Emissions Estimation Technique Manual for Aggregated Emissions from Commercial Ships/Boats and Recreational Boats. Version 1.0. Commonwealth of Australia.

National Oceanic and Amospheric Administration (NOAA). (2014). Oil Spills in Mangroves – Planning & Response Considerations. National Ocean Service, Office of Response and Restoration. September, 2014.

Negri, A, P. and Heyward, A. J. (2000). Inhibition of fertilization and larval metamorphosis of the coral Acropora millepora (Ehrenberg, 1834) by petroleum products. Marine Pollution Bulletin 41(7-12): 420-427.

Nicholas, W.A., Smit, N., Siwabessy, P.J.W., Nanson, R., Radke, L., Li, J., Brinkman, R., Atkinson, R., Dando, N., Falster, G., Harries, S., Howard, F.J.F., Huang, Z., Picard, K., Tran, M., and Williams, D. (2019). Characterising Marine Abiotic Patterns in the Darwin-Bynoe Harbour region: Summary report, Physical Environments, Darwin Harbour Mapping Project. Department of Environment and Natural Resources, Darwin, Northern Territory, Australia. Available at: http://pid.geoscience.gov.au/dataset/ga/127386 [Accessed 17/05/2021].

Northern Territory Government. (2011). Northern Territory Government, East Arm Wharf Expansion Project, Draft Environmental Impact Statement, Executive Summary. Available at: https://ntepa.nt.gov.au/__data/assets/pdf_file/0012/286788/EAW-Exec-Summary.pdf [Accessed 01/11/2021].

Northern Territory Environment Protection Authority (NT EPA). (2013). Guidelines for the Environmental Assessment of Marine Dredging in the Northern Territory, Environment Protection Authority, November 2013, Version 2.0.

Northern Territory Government. (2019a). Department of Environment, Parks and Water Security, environment website accessed (06/10/21) of https://nt.gov.au/environment/animals/feral-animals/exotic-ants/browsing-ant

Northern Territory Government. (2019b). Status of Key Northern Territory Fish Stocks Report 2015 (No. Fishery Report No. 121). Department of Primary Industry and Resources, Darwin, Northern Territory.

Northern Territory Government. (2019c). Northern Territory Government. (2020). The Northern Territory Climate Change Response: Towards 2050. Office of Climate Change, Department of

Environment and Natural Resources, Northern Territory Government, July 2020. Available at: https://depws.nt.gov.au/__data/assets/pdf_file/0005/904775/northern-territory-climate-change-response-towards-2050.pdf [Accessed 01/11/2021].

Department of Agriculture, Water and Resources (DoAWR). (2016). Fishery Status Reports 2016, September 2016. Department of Agriculture, Water and Resources, Canberra, Australia Capital Territory.

NT Government. (2009). Sites of Conservation Significance: Darwin Harbour, fact sheet. NT Government. Darwin, Australia.

Northern Territory Government. (2019). Arts, culture and heritage: Maritime heritage. Available at: https://nt.gov.au/leisure/arts-culture-heritage/visit-a-cultural-or-heritage-site/maritime-heritage. Accessed [26/10/2021].

Northern Territory Government. (2021a). Commercial fishing: Boating, fishing and marine. Available at: URL https://nt.gov.au/marine/commercial-fishing Accessed [02/11/2021].

Northern Territory Government. (2021b) Demersal Fishery and Licences. Demersal fishery and licences - NT.GOV.AU Accessed [02/11/2021]

Northern Territory Government (2021b). Middle Arm Peninsula Strategic Development Plan

Northern Territory Environment Protection Authority (NT EPA). 2013. Guidelines for the Environmental Assessment of Marine Dredging in the Northern Territory. Version 2.0, NT EPA, Darwin.

NT EPA. (2021a). Referring a proposal to the NT EPA, Environmental Impact Assessment Guidance for proponents.

NT EPA. (2021b). Stakeholder Engagement and Consultation – Environmental Impact Assessment Guidance for Proponents. Version 2.0 (dated 6 January 2021), NT EPA, Darwin.

NT EPA. (2021c). NT EPA Environmental Factors and objectives: Environmental impact assessment general technical guidance.

NT EPA. (2021d). Environmental impact assessment and environmental approval in the Northern Territory, Environmental impact assessment guidance.

Padovan, A.V. (1997). The water quality of Darwin Harbour: October 1990–November 1991. Water Quality Branch, Water Resources Division, Department of Lands, Planning and Environment, NT Government, Report No. 34/1997D December 1997.

Parra, G.J, and Jedensjö, M. (2009). Feeding habits of Australian snubfin (Orcaella heinsohni) and Indo-Pacific humpback dolphins (Sousa chinensis). Project report to Reef and Rainforest Research Centre Limited, Cairns, Queensland.

Pendoley. (2019). ConocoPhillips Barossa Project - potential impacts of pipeline installation activities on marine turtles - literature update (No. J54001 Rev 2). 5 July 2019. Unpublished report prepared by Pendoley Environmental Pty Ltd for Jacobs.

Phillips Petroleum Company Australia Pty Ltd. (2002). Darwin LNG Plant, Environmental Management Programme, Volume II Construction EMP, Perth, Western Australia

Phillips Oil Company Australia Pty Ltd. (1997). Darwin LNG Plant. Draft Environmental Impact Statement, Volume 1, Prepared by Dames and Moore.

Polovina, J.J., Balazs, G.H., Howell, E.A., Parker, D.M., Seki, M.P., and Dutton, P.H. (2004). Forage and migration habitat of loggerhead (Caretta caretta) and olive ridley (Lepidochelys olivacea) sea turtles in the central North Pacific Ocean. Fisheries Oceanography 13, 36–51.

Popper, A. N., Hawkins, A. D., Fay, R. R., Mann, D. A., Bartol, S., Carlson, T. J., and Tavolga, W. N. (2014). Sound exposure guidelines. In ASA S3/SC1. 4 TR-2014 Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI (pp. 33-51). Springer, Cham.

Radford, B., Heyward, A., Birt, M.J., Case, M., Colquhoun, J., Currey-Randall, L.M., Stowar, M.J., Vaughan, B.I., Wyatt, M. (2019). Oceanic Shoals Commonwealth Marine Reserve (CMR) final quantitative report on benthic habitats (Report No. AIMS/COP/RPT/002/2019). Australian Institute of Marine Science, Perth, Western Australia.

Radke, L., Majid, M., Mummery, A., Lambrinidis, D., Logan, M,, and Wyatt, J. (2020). Sediment quality assessment of Outer Darwin Harbour (2020): Survey record and data report. Technical Report No. 38/2020. Department of Environment and Natural Resources, Northern Territory Government, Darwin, Northern Territory.

Radke, L.C and Fortune, J. (2020). Anthropogenic Pressures on Darwin Harbour: An IMMRP Monitoring Plan (Version 1). Technical Report No. 11/2020., Department of Environment and Natural Resources, Northern Territory Government, Darwin, Northern Territory.

RPS Group. (2021). Santos Barossa DPD Environmental Baseline Survey, Interim Field Report #1, Perth, Western Australia.

Rochester, WA, Moeseneder, CH, Miller, MJ, Milton, DA, Fry, GC, Griffiths, SP, Pillans, RD, Rothlisberg, PC, Bustamante, RH, Butler, AJ. (2007). The north marine region marine bioregional plan: information and analysis for the regional profile, final report to the Australian Government Department of the Environment and Water Resources, CSIRO Marine and Atmospheric Research, Cleveland.

Runcie, J., Macinnis-Ng, Cate., Ralph, P. (2004). The Toxic Effects of Petrochemicals on Seagrass. Literature Review. Institute for Water and Environmental Resource Management and Department of Environmental Sciences University of Technology, Sydney. Prepared for Australian Maritime Safety Authority.

Saalfeld K, Fukuda Y, Duldig T and Fisher A (2016). Management Program for the Saltwater Crocodile (Crocodylus porosus) in the Northern Territory of Australia, 2016-2020. Northern Territory Department of Environment and Natural Resources, Darwin.

Saenger, P. 1994. Cleaning up the Arabian Gulf: Aftermath of an oil spill. Search 25: 19-22.

Salmon, M. (2003). Artificial night lighting and sea turtles. Biologist 50, 163–168.

Salmon, M., Wyneken, J., Fritz, E., and Lucas, M. (1992). Seafinding by Hatchling Sea Turtles: Role of Brightness, Silhouette and Beach Slope as Orientation Cues. Behaviour 122, 56–77.

Salmon, M. and Witherington, B.E. (1995). Artificial lighting and seafinding by loggerhead hatchlings: evidence for lunar modulation. Copeia 931–938.

Santos. (2021). Barossa Gas Export Pipeline Installation Environment Plan. Santos. Perth, Western Australia.

Semeniuk, V. (1985). Mangrove environments of Port Darwin, Northern Territory: the physical framework and habitats. Journal of the Royal Society of Western Australia, 67, 81–97.

Shigenaka, G. (2001). Toxicity of oil to Reef-Building Corals: A Spill Response Perspective. National Oceanic and Atmospheric Administration, Office of Response and restoration, Washington.

Sinclair Knight Merz (SKM). (2011). INPEX: Ichthys Gas Development Project, Assessment of potential impacts to mud crabs in Darwin Harbour. Prepared for INPEX Browse, Ltd. Perth, Western Australia.

Siwabessy, P.J.W., Smit, N., Atkinson, I., Dando, N., Harries, S., Howard, F.J.F., Li, J., Nicholas, W.A., Potter, A., and Radke, L.C. (2016). Outer Darwin Harbour Marine Survey 2015: GA0351/SOL6187 – Post-survey report. Record 2016/08. Geoscience Australia, Canberra, Australian Capital Territory.

Smit, N., Penny, SS., and Griffiths, AD. (2012). Assessment of marine biodiversity and habitat mapping in the Weddell region, Darwin Harbour. Report to the Department of Lands, Planning and Environment. Department of Land Resource Management, Darwin, Northern Territory.

Smith, S. and Hill, J. (2011). Supporting Sustainable Development – Risks and Impacts of Plant Industries on Soil Condition. Northern Territory Government, Australia. Technical Bulletin No. 340.

Southall, B. L., Finneran, J. J., Reichmuth, C., Nachtigall, P. E., Ketten, D. R., Bowles, A. E., and Tyack, P. L. (2019). Marine mammal noise exposure criteria: updated scientific recommendations for residual hearing effects. Aquatic Mammals, 45(2).

Stapput, K. and Wiltschko, W. (2005). The sea-finding behavior of hatchling olive ridley sea turtles, Lepidochelys olivacea, at the beach of San Miguel (Costa Rica). Die Naturwissenschaften 92, 250–3. https://doi.org/10.1007/s00114-005-0619-z.

Taylor, H.A. and Rasheed, M.A. (2011). Impacts of a fuel oil spill on seagrass meadows in a subtropical port, Gladstone, Australia – The value of long-term marine habitat monitoring in high risk areas. Marine Pollution Bulletin 63: 431-437.

Thums, M., Whiting, S.D, Reisser, J.W., Pendoley, K.L., Pattiaratchi C.B., Proietti, M., Hetzel, Y., Fisher, R. and Meekan, M.G. (2013). Tracking sea turtle hatchlings – A pilot study using acoustic telemetry. Journal of Experimental Marine Biology and Ecology, 440, 156-163.

URS Corporation. (2002). Darwin 10 MTPA LNG Facility. Public Environmental Report. Prepared for Phillips Petroleum Company Pty Ltd. March 2002.

URS. (2014). Tug Pen and Small Vessel Berths Dredge and Dredge Spoil Placement Management Plan, Prepared for Darwin Port Corporation.

Walsh, K. J. E., H. Betts, J. Church, A. B. Pittock, K. L. Mclnnes, D. R. Jackett and T. J. McDougall. (2004). Using Sea Level Rise Projections for Urban Planning in Australia. Journal of Coastal Research, 20(2), 586–598. http://www.jstor.org/stable/4299312.

WAMSI. (2019). Dredging Science Node – Final Synthesis Report. Western Australian Marine Science Institution, Perth, Western Australia.

Warchot, A., and Whelan, P. (2011), East Arm Port Expansion Project Biting Insect Investigation October

Wei, Y., Wang, Y., Di, Q., Choirat, C., Wang, Y., Koutrakis, P., Zanobetti, A., Dominici, F. and Schwartz, J.D. (2019). Short term exposure to fine particulate matter and hospital admission risks and costs in the Medicare population: time stratified, case crossover study. bmj, 367.

West, L.D., Stark, K.E., Murphy, J.J., Lyle, J.M., Ochwada-Doyle, F.A. (2015). Survey of recreational fishing in New South Wales and the ACT, 2013/14. Fisheries Final Report Series No. 149. NSW Department of Primary Industries, Wollongong.

Williams, D., Wolanski, E.J., and Spagnol, S.B. (2006). Hydrodynamics of Darwin Harbour. pp. 461-476. In: Wolanski EJ (ed) The Environment in Asia Pacific Harbours.

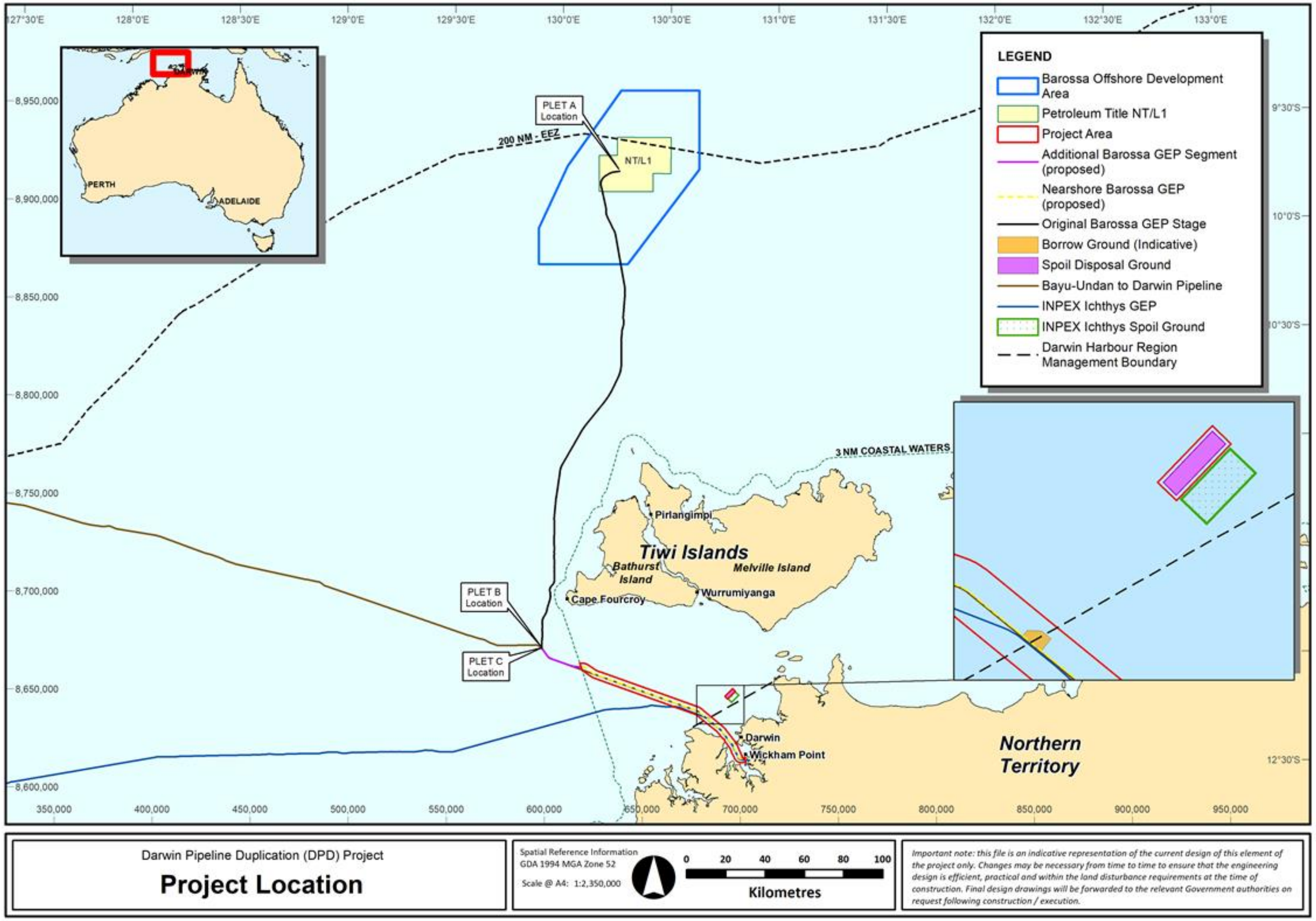
Wilson, K. and Ralph, P. (2010). Effects of oil and dispersed oil on temperature seagrass: scaling of pollution impacts. Final report to Australian Maritime Safety Authority, August 2010. University of Technology, Sydney, New South Wales.

Wilson, S., Polovina, J., Stewart, B., and Meekan, M. (2006). Movements of whale sharks (Rhincodon typus) tagged at Ningaloo Reef, Western Australia. Marine Biology 148, 1157–1166.

Witherington, B.E. and Martin, R.E. (2003). Understanding, assessing and resolving light-pollution problems on sea turtle nesting beaches. Florida Marine Research Institute Technical Report TR-2 3rd Edition Revised, Florida Department of Environmental Protection, Tequesta, Florida, United States of America.

Santos

Appendix A – Darwin Pipeline Duplication (DPD) Project Overview Figure



NT Legislation

Legislation	Government Department	Summary of Environmental Legislation
Darwin Port Corporation Act 2015 and Port By-Laws	Darwin Port Corporation	Clause 16. Functions of Darwin Port Corporation. Darwin Port Corporation is responsible for the movement of all vessels within the Port limits. Port officers act as Agents for the prevention, management and control of pollution by oil in this jurisdiction. Clause 29. Directions for movement and control of vessels within the Port, including traffic, mooring and anchoring of vessels. Consideration of this Act and By-Laws will be required to plan vessel movements, trenching and pipelaying works, spoil disposal and establishment of a Precautionary Zone for the protection of the pipeline.
Energy Pipelines Act and Regulations 2015	Department of Industry, Tourism and Trade (DITT)	The Act provides for the construction, operation, maintenance and cessation of use or abandonment of pipelines for the conveyance of energy-producing hydrocarbons, and for related purposes. Part III of the Act details the requirements for renewal and variation of pipeline licences. The Regulations outline the consent requirements to operate, modify or decommission pipelines, and the content requirements of a Pipeline Management Plan to manage pipeline related activities. A licence to operate the pipeline will be required for the Project. This will require the development of a Pipeline Management Plan.
Fisheries Act 1988	DITT – Fisheries Division	The Act makes it illegal to pollute waters where the effect of the substance is that fish or aquatic life are injured, detrimentally affected or the habitats, food or spawning grounds are detrimentally affected. Consideration of this Act is required in the assessment of potential impacts and mitigation measures for the construction of the pipeline.

Legislation	Government Department	Summary of Environmental Legislation
Heritage Act 2011 and Regulations 2012	DITT	The Act provides for the conservation of the NT's cultural and natural heritage. The Heritage Council established under the Act makes assessments and regulate work on heritage places. All sites on the NT Heritage Register and yet to be discovered sites are protected under this Act. Heritage values include both marine and terrestrial. Heritage values will be identified and avoided as part of the Project development plan.
Marine Pollution Act 1999 and Regulations 2003	Department of Environment, Parks and Water Security (DEPWS)	The objective of the Act is to protect the marine and coastal environment from ship/boat sourced pollution. This includes litter/ rubbish, hydrocarbons and substances that may be hazardous to the marine environment (including substances that may be in ballast and grey water). All marine activity during the Project development will adhere to the requirements of this Act.
Northern Territory Aboriginal Sacred Sites Act 1989 and Regulations 2004	Aboriginal Areas Protection Authority (AAPA)	The Act depicts the need to preserve and promote Aboriginal tradition in relation to land in the NT. This Act establishes procedures for the protection and registration of sacred sites. The Act establishes offences for entry onto, work on or, desecration of, sacred sites without appropriate certification or in contravention of the certification. This Act creates the Aboriginal Areas Protection Authority (AAPA), which issues (Sacred Sites) Certificates for specific areas. These certificates advise of sacred sites within an area. Approval must be sought and obtained before sacred sites can be disturbed or destroyed. An Aboriginal sacred sites survey of the DLNG facility site was conducted prior to clearance for construction. Sites remaining in situ are marked and must not be disturbed. A survey for Aboriginal sites must be conducted prior to any future site clearance work. Through consultation with the AAPA as part of pre-referral engagement, it has been confirmed that an AAPA Certificate for the DPD works is required. Santos is in the process of preparing an application to AAPA, at the time of this referral.

Legislation	Government Department	Summary of Environmental Legislation
Planning Act 1999 and Regulations 2000	Department of Infrastructure, Planning and Logistics (DIPL)	The Act provides framework of controls for the orderly use and development of land. The objective of the Act includes ensuring that strategic planning is applied to planning schemes and implemented in individual planning decisions, promotion of sustainable development of land and promotion of the responsible use of land and water resources to limit the adverse effects on development of ecological processes. Division 2 of the Act provides the planning basis for the submission, review and authorisation of Exceptional Development Permits (EDPs), and related EDP variations. An EDP has been issued for the DLNG facility to which the Project will tie-into.
Territory Parks and Wildlife Conservation Act 1976 and Regulations 2001	DEPWS	The Act forms a framework for the establishment and management of parks and reserves and declaration of protected wildlife. This Act has been considered with regard to the potential interactions with protected wildlife.
Waste Management and Pollution Control Act 1998	DEPWS	The Act protects the environment through the encouragement of effective waste management and prevention and control practices of pollution. Section 30 of the Act specifies that certain activities undertaken in the Northern Territory require an Environment Protection Licence (EPL). The DLNG facility operates under EPL217-02. Management of waste and discharges during the Project construction will be in compliance with this Act.
Water Act 1992	DEPWS	An Act to provide for the investigation, allocation, use, control, protection, management and administration of water resources, and for related purposes. Under this Act, the waters of Darwin Harbour (and the marine reaches of rivers draining into it) were declared to have “beneficial uses” for the protection of aquatic ecosystems, recreational water quality and aesthetics. It is an offence under this Act to pollute the declared waterways and impact on the beneficial uses.

Legislation	Government Department	Summary of Environmental Legislation
		Section 74 of the Act delegates powers to the NT EPA Chair to grant waste discharge licences for discharge of waste to water. An Application for a Waste Discharge Licence (WDL) is required for discharges, such as hydrotest/dewatering, dredging and spoil disposal, to Darwin Harbour and creeks or rivers draining into the Harbour.
Weeds Management Act 2001 and Regulations	DEPWS	An Act to prevent the spread of weeds in and out of the Territory, and to ensure that the management of weeds is an integral part of land management. Management of weeds for this Project will be in compliance with this Act.

Commonwealth Legislation

Legislation	Government Department	Summary of Environmental Legislation
Australian Heritage Council Act 2003	Department of Agriculture, Water and the Environment (DAWE)	This Act identifies areas of heritage value listed on the Register of the National Estate and sets up the Australian Heritage Council and its functions.
Environment Protection (Sea Dumping) Act 1981	DAWE	The Sea Dumping Act implements Australia's obligations under the London Protocol, which aims to prevent marine pollution by dumping of wastes and other matter. The Act applies in all Australian waters, except areas determined to be within the limits of a State or of the NT. Therefore, States and the NT can legislate to control sea dumping in their adjacent three nautical miles of sea if State/Territory legislation conforms with the Sea Dumping Act (Section 9 of the Act). As such, if a spoil disposal ground is required for the DPD project and it is located within NT waters, the Sea Dumping Act does not apply; thereby negating the need for a sea dumping permit. The NT EPA have published guidelines for the environmental assessment of marine dredging, which cover spoil grounds (NT EPA, 2013). Therefore, in NT Territorial waters, approvals for spoil ground placement and disposal, is within the remit of Northern Territory jurisdiction.
Historic Shipwrecks Act 1976 and Historic Shipwrecks Regulations 1978	DAWE	This Act protects shipwrecks that have lain in territorial waters for 75 years or more. It is an offence to interfere with any shipwreck covered by the Act.
National Greenhouse and Energy Reporting Act 2007 National Greenhouse and Energy Reporting Regulations 2008	Clean Energy Regulator	The National Greenhouse and Energy Reporting Act 2007 (NGER Act) provides a single national framework for the reporting and dissemination of information related to greenhouse gas emissions, greenhouse gas projects, energy production and energy consumption, and for other purposes. The safeguard mechanism requires businesses that have facilities with direct emissions of >100,000 tonnes of carbon dioxide equivalence a year to keep net emissions at or below baseline emissions levels.

Legislation	Government Department	Summary of Environmental Legislation
National Greenhouse and Energy Reporting (Safeguard Mechanism) Rule 2015 Emissions Reduction Fund and associated Carbon Credits (Carbon Farming Initiative) Rule 2015 (established under the Carbon Credits (Carbon Farming Initiative) Act 2011)		Emissions Reduction Fund (ERF) incentivises Australian businesses to reduce the amount of greenhouse gas (GHG) emitted and promotes activities that store carbon. Eligible projects can earn Australian Carbon Credit Units (ACCUs) for every tonne of emissions reduced or stored through a project.
Offshore Petroleum and Greenhouse Gas Storage Act 2006 (OPGGS Act) and Offshore Petroleum Greenhouse Gas Storage (Environment) Regulations 2009 (OPGGS (E) Regulations) Offshore Petroleum and Greenhouse Gas Storage (Safety) Regulations 2009 Offshore Petroleum and Greenhouse Gas Storage (Resource Management	NOPSEMA	The OPGGS Act provides protection of the environment in Commonwealth waters (as well as designated State and NT waters where functions have been conferred) through ensuring that all offshore petroleum and greenhouse gas storage activities are undertaken in a manner where impacts on the environment, including those Matters of National Environmental Significance (MNES) protected under Part 3 of the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act), are of an acceptable level and reduced to 'as low as reasonably practicable' (ALARP). The Act provides for the granting or renewal of pipeline licences while the regulations facilitate the regulation of environmental and safety management of offshore petroleum and greenhouse gas pipelines. The Commonwealth waters section of the Project is being addressed through an Environment Plan Revision to the existing Barossa GEP EP, to be submitted separately to NOPSEMA under the OPGGS (E) Regulations.

Legislation	Government Department	Summary of Environmental Legislation
and Administration) Regulations 2011		
Underwater Cultural Heritage Act 2018		Provides for the protection of shipwrecks, sunken aircrafts and ither types of underwater cultural heritage within Australian waters, and is relevant to the underwater cultural heritage values within Darwin Harbour.

Santos

Existing environmental approvals relevant to the Project

Approval	Summary
DLNG Development Approvals	
DLNG Facility Environmental Impact Statement (EIS)	The DLNG Facility was assessed under an EIS by the Northern Territory Environment Protection Authority (NT EPA) under the Northern Territory (NT) Environmental Assessment Act 1982 and approved under a set of recommendations in February 1998. The scope of the EIS comprised a single liquefication train to produce liquefied natural gas (LNG) up to 3 million tonnes per annum (MTPA) and consideration of the effects of potential future expansion to an LNG facility of 9 MTPA nominal capacity. It was recommended that any revised proposal for future expansion b submitted to the NT Government for further assessment under the NT Environmental Assessment Act 1982.
DLNG Public Environmental Report (PER)	A revised proposal was submitted to the NT EPA under the NT Environmental Assessment Act 1982 in March 2002, for expansion to a maximum 10 MTPA facility, comprising two LNG trains, each with a maximum output of 5 MTPA. The revised proposal also allowed for gas to be sourced from a number of Timor Sea gas fields (including the Barossa Field), in addition to the Bayu-Undan Field, as nominated in the approved EIS. The revised proposal was assessed as a PER and concurrently reviewed under the Administrative Procedures approved under the Commonwealth Environment Protection (Impact of Proposals) Act 1974 (now repealed and replaced by the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)).
Exceptional Development Permit	The DLNG (10 MTPA) Exceptional Development Permit (EDP) (02/0015) was issued by the NT Minister for Lands and Planning on 11 November 2002 for development of the facility in two stages. The EDP provides conditions for air emissions, emergency response, flora and fauna management, waste management, water and wastewater management, heritage protection requirements and visual amenity considerations (ConocoPhillips, 2019a). Subsequent variation permits have been issued, and currently the permit is operated under EDP02/0015G (issued in November 2016).
Barossa Development Approvals	
Barossa Area Development Offshore Project Proposal	ConocoPhillips (now Santos) submitted an Offshore Project Proposal (OPP) for development of the Barossa Field. The OPP included the in-field infrastructure in the Barossa Field, including a Floating Production Storage and

Approval	Summary
	Offloading (FPSO) facility and supporting in-field subsea infrastructure, and a new approximately 260 km subsea gas export pipeline (GEP) that connected into the existing operational Bayu-Undan to Darwin pipeline (at Kilometre Point (KP) 380). The Barossa development will backfill Darwin LNG when the Bayu-Undan to Darwin pipeline ceases production. The OPP was accepted by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) in March 2018.
Original Barossa GEP Stage Installation Environment Plan (EP)	The original Barossa GEP Stage Installation EP identifies and evaluates the potential environmental impacts and risks associated with the installation of the Original Barossa GEP Stage in Commonwealth waters. The pipeline installation activities addressed in the EP consist of: + pre and post lay surveys; + pre and post lay span rectification; + installation of the gas export pipeline and end terminals, including foundations, flooding, cleaning, gauging and testing, dewatering; and + pipeline pre-conditioning activities. A revision of the original Barossa GEP Stage Installation EP introducing a new stage of the Gas Export Pipeline (e.g. the additional Barossa GEP segment in Commonwealth Waters is being prepared at the time of submitting this referral.
Barossa Future Activities EP	Santos will be required to submit a series of EPs to NOPSEMA to enable the development of the Barossa Field. Currently, the Development Drilling and Completions EP has been submitted and the original Barossa GEP Stage Installation EP (already accepted by NOPSEMA, as per above) is currently being revised to include the section of the DPD Project within Commonwealth Waters (e.g. additional Barossa GEP segment). It is anticipated the EPs for the future activities will be packaged as follows: + Moorings Installation EP; + Subsea Umbilicals Risers and Flowlines Installation and Pre-commissioning EP; + FPSO and Operations EP; and + Barossa GEP Start-Up and Operations EP.

Approval	Summary
Operational Approvals	
Bayu-Undan GEP Operations EP	ConocoPhillips (now Santos) submitted an EP to NOPSEMA for activities associated with the operation and maintenance of the Bayu-Undan to Darwin pipeline to comply with the OPGGS(E) Regulation 11(1) and the NT Energy Pipelines Act. The pipeline is a dry natural gas export pipeline that transports gas from the Bayu-Undan Field, located in Timor-Lesté waters, to the DLNG facility. The pipeline overlaps three jurisdictions and has several associated pipeline licences, these being: Timor-Leste waters (BU-1-PL), Commonwealth waters (WA-8-PL and NT/PL1) and NT coastal waters (PL20 and NTC/PL1). The Bayu-Undan GEP Operations EP was accepted by NOPSEMA in February 2019.
DLNG Operations Environmental Management Plan (OEMP)	The DLNG OEMP defines the battery limits of the facilities and details the credible environmental risks and risk management controls associated with the operation of the DLNG facility. The OEMP is updated every five years, at a minimum. The last update of the OEMP was undertaken in August 2018 as part of the five year review cycle.
Environment Protection Licence (EPL)	The EPL is issued under Section 34 of the NT Waste Management and Pollution Control Act 1998. The EPL is required for DLNG as it is an operating premises for processing hydrocarbons so as to produce, store and/or dispatch liquefied natural gas or methanol in excess of 500,000 tonnes annually. The DLNG EPL-LNG 01 was issued by the Executive Director of the NT EPA on 9 December 2005 for the production of LNG and natural gas liquids at the DLNG production plant at Wickham Point, with nameplate production capacity equivalent to 3.7 MTPA. Subsequent licences have been issued, with the last being issued in July 2018 (EPL 217-02).
DLNG Transition Work Program Notice of Intent (NOI)	A NOI for the DLNG Transition Work Program was submitted to the NT EPA for assessment in October 2019 to determine whether or not formal assessment is required pursuant to the NT Environmental Assessment Act. The NT EPA decided that the potential environmental impacts and risks associated with the work program did not warrant environmental impact assessment by the NT EPA at the level of a PER or EIS. The scope of the NOI included the modification and refurbishment of the current DLNG facilities to support the new feed gas supply and extend operation of the DLNG beyond its original design life to approximately 2050. The DLNG Transition Work Program comprises two key phases; a transition period, followed by future (extended) operations to approximately 2050. In the transition period, production will cease from the existing Bayu-Undan gas supply and the facility will be on warm standby prior to introduction of the new gas supply. The transition period is

Approval	Summary
	an enabling window for key work scopes to be completed to ensure the DLNG facility is ready for continued operations with the new feed gas supply.

Appendix C – Stakeholder Engagement Plan

Santos

Darwin Pipeline Duplication (DPD) Project – Stakeholder Engagement Plan

PROJECT / FACILITY	DPD
REVIEW INTERVAL (MONTHS)	No Review Required
SAFETY CRITICAL DOCUMENT	NO

Rev	**Owner**	**Reviewer/s** *Managerial/Technical/Site*	**Approver**
0	Barossa Stakeholder Adviser	Barossa Environmental Approvals Adviser	Barossa HSE Manager

Any hard copy of this document, other than those identified above, are uncontrolled. Please refer to the Santos Offshore Business Document Management System for the latest revision.

Contents

TABLES

1 Introduction

1.1 Project Summary

Santos' Darwin Pipeline Duplication (DPD) Project will enable natural gas from offshore reservoirs to be exported to the existing Santos Darwin Liquefied Natural Gas Facility (DLNG) with minimal environmental and social impact. Similar gas export pipeline developments have been successfully managed in the Northern Territory, and there is a significant body of knowledge available that provides confidence in the environmental assessment and management effectiveness.

Importantly, executing the DPD Project in a timely manner preserves the existing Santos Bayu-Undan to Darwin Pipeline for re-purposing opportunities into the future including carrying carbon dioxide for offshore carbon capture and storage (CCS). This opportunity will help Santos meet its emission reduction targets and achieve net-zero Scope 1 and 2 absolute emissions by 2040.

Santos' Darwin Pipeline Duplication (DPD) Project includes a ~23 km segment in Commonwealth waters (referred to as the 'Additional Barossa GEP Segment) and ~100-km segment in NT waters and lands (referred to as the 'Nearshore Barossa GEP'). The Project pipeline will be located parallel to the existing Bayu-Undan to Darwin Pipeline, to minimise potential environmental and social impacts.

The Referral supporting information document addresses the activities required to construct and operate the new pipeline segment in NT waters and lands only (e.g. the Nearshore Barossa GEP; herein referred to as the 'Project'). This document provides supporting information to the Referral Form for the DPD Project in NT waters and lands submitted under Section 48 of the NT Environment Protection Act 2019 to the NT Environment Protection Authority (NT EPA). The conclusion that the Project activities will have minimal impact and are readily manageable using well established pipeline construction and operational practices is based on the following:

+ The Project is smaller in scale to previous gas export pipeline and marine infrastructure developments within Darwin Harbour.
+ The Project is immediately adjacent to the existing Santos Bayu-Undan to DLNG Pipeline and the shore crossing is located within the existing DLNG disturbance footprint.
+ There are a limited number of environmental factors requiring detailed assessment and focused management. These marine-based factors, as defined by the NT EPA, are Marine Environmental Quality, Marine Ecosystems and Coastal Processes. All other environmental factors are considered insignificant following a screening process, as presented within the document.
+ There is a substantial body of location-specific scientific and management knowledge, with the key environmental and social values in the area being well understood. Santos has conducted recent environmental surveys to confirm the absence of sensitive or restricted environmental receptors along the Project pipeline.
+ There is confidence in the effectiveness of the proposed management measures based on previous experiences and as validated by extensive environmental monitoring results.
+ Proactive stakeholder engagement to ensure concerns and issues continue to be identified and effectively managed.

1.2 Purpose

This Stakeholder Engagement Plan (SEP) has been developed to create a structured process of engagement that sets out Santos's vision for engagement, guides Project team members on their engagement and enables Santos to articulate its commitments clearly and transparently to Government, community and other stakeholders.

The SEP will enable Santos to build an understanding of stakeholder values and concerns by creating meaningful opportunities for stakeholder participation from the early stages of preparation for the Project environmental referral.

Importantly, the Northern Territory Environment Protection Authority (NT EPA) obligates proponents to inform and seek community involvement, in a culturally appropriate manner, about potential environmental impacts and risks of a proposal. Section 3(d) and 3(e) of the *Environment Protection Act 2019* (EP Act) states the objects of the EP Act are to:

+ *"To provide for broad community involvement during the process of environmental impact assessment and environmental approval"; and*
+ *"To recognise the role that Aboriginal people have as stewards of their country as conferred under their traditions and recognised in law, and the importance of participation by Aboriginal people and communities in environmental decision-making processes."*

Proponents must seek and document community knowledge and understanding of the area, including traditional Aboriginal knowledge, and use this expertise in identifying impacts and risks, and then planning for the avoidance or mitigation of those impacts and risks. As such, the stakeholder input received as a result of engagement stemming from this SEP has fed into the Project environmental assessment.

It is important to note the spatial and community context for which the Project is located. The Project is proposed in a pre-existing pipeline corridor subject to existing disturbance. It is in the Darwin Harbour and Middle Arm Peninsula and offshore marine environment in NT waters with direct stakeholder consultation predominantly focused on the users of these areas.

1.3 Outcomes and Objectives

1.3.1 Outcomes

Engagement for the Project is focused on achieving the following outcomes:

+ All identified key stakeholders are appropriately informed of the Project;
+ Stakeholders are provided with meaningful opportunities to participate in consultation for the Project;
+ Traditional Owners are provided opportunities for meaningful engagement and their culture and values respected; and
+ The Project specific environmental assessment has been actively informed by the input and feedback received from stakeholders.

1.3.2 Objectives

The SEP aims to achieve outcomes by:

+ Creating a structured process focused on:
  - Building trust and mutual understanding between Santos and Project stakeholders
  - Addressing statutory stakeholder consultation requirements
  - Meaningfully engaging with stakeholders, specifically with regards to the environmental assessment and approvals process.
+ Providing opportunities for Santos to understand stakeholder values and expectations;
+ Embedding the importance of using local contractors and employees as much as possible throughout the Project;
+ Ensuring that Traditional Owners and Indigenous groups are engaged;
+ Securing stakeholder feedback that will be used as input for the environmental assessment process and to inform Santos' longer-term activities and community involvement; and
+ Aligning with Santos' Corporate approach to stakeholder engagement.

1.4 Regulatory Requirements

As per the NT EPA environmental impact assessment guidance, proponents are responsible for undertaking stakeholder engagement and consultation from the earliest stage of the environmental impact assessment process and continuing throughout the process.

Santos is required to provide details of any stakeholder engagement and consultation undertaken to meet the requirements of section 43 of the EP Act and outline how this consultation has informed the assessment; including the environmental impact assessment, identification and management of impacts, and selection of offsets. Section 43 of the EP Act provide the general duty of proponents and states the following with regard to stakeholder consultation:

A proponent of an action has the following general duties under an environmental impact assessment process:

a. *To provide communities that may be affected by a proposed action with information and opportunities for consultation to assist each community's understanding of the proposed action and its potential impacts and benefits;*
b. *To consult with affected communities, including Aboriginal communities, in a culturally appropriate manner; and*
c. *To seek and document community knowledge and understanding (including scientific and traditional knowledge and understanding) of the natural and cultural values of areas that may be impacted by the proposed action."*

The NT EPA guidance related to stakeholder consultation focuses on an ongoing process of stakeholder engagement that involves building relationships, actively sharing information, and bringing stakeholder voices into decisions that may affect or interest them. The Project SEP has been prepared with this outcome as a key focus.

2 Engagement Approach

2.1 Overview of Approach

Santos is committed to undertaking projects in a manner that will both deliver on regulatory requirements and engage and contribute to the communities in which it operates. More broadly, Santos is focused on understanding and integrating those matters that will ensure the long-term outcomes aspired to by relevant stakeholders. The key focus will be on:

+ Governance and systems frameworks to support the business operations and how Santos works with stakeholders;
+ The formation of long-term, meaningful relationships and partnerships with stakeholders;
+ Alignment with relevant Northern Territory standards regarding stakeholder impact assessment, management and social investment; and
+ An active risk management approach and a focus on creating longer term value for the communities where Santos operates.

2.2 Principles for Project Engagement

In developing its approach for project engagement, Santos has referred to industry leading standards and practice including the Northern Territory Stakeholder Engagement and Consultation guidance (NT EPA, 2021a), Northern Territory guidance for preparing an environmental impact statement ((NT EPA, 2021b), the International Association for Public Participation's (IAP2) Quality Assurance Standard For Community and Stakeholder Engagement (IAP2, 2015) and relevant International Finance Corporation guides (IFC, 2007).

As outlined above, Santos actively builds community investment into its overall business and planning process. Engagement for this Project will be based on the following key principles:

+ Focusing on achieving genuine outcomes for communities;
+ Providing a flexible and proactive approach;
+ Being visible and transparent;
+ Where investment in communities is undertaken, supporting projects that encourage community self-sufficiency and sustainability; and
+ Enhancing social return on investment through strategic reviews of outcomes.

To achieve engagement objectives and outcomes it is important to define and explain the parameters of the Project including decisions that have already been made, decision-making processes and governance structures, statutory obligations and regulatory requirements. When Santos engages with stakeholders it is important that there is clarity regarding what can and cannot be influenced with regards to the Project. This is particularly important in terms of managing stakeholder expectations. The following points provide a frame of reference for what can and cannot be influenced.

2.2.1 What Can Stakeholders Influence

The following are identified as aspects stakeholders can influence:

+ How and when stakeholders are engaged across the Project lifecycle;
+ Identification of potential Project impacts through provision of local knowledge;
+ Considerations in the environmental assessment process and the supporting studies (e.g. information considered or assessed);
+ How Santos manages potential impacts (e.g. selection of control in accordance with the environmental decision-making process) and maximises potential opportunities/benefits;
+ The type and frequency of Project consultation they receive going forward; and
+ How Santos works with the local community and focuses on local priorities.

2.2.2 What Stakeholders Cannot Influence

The following are aspects stakeholders cannot influence:

+ The location of the Project;
+ The focus on achieving genuine outcomes for the local community, company workers and Santos shareholders; and
+ Approaches or requirements that must be implemented due to statutory obligations and regulatory requirements.

2.3 Engagement Undertaken to Date

Santos has undertaken initial engagement during Project planning and feasibility. The focus of initial engagement has been with key stakeholders, including government agencies, representative bodies regular Harbour users and the Port of Darwin where a significant portion of the project activities will be undertaken. A summary of consultation to date is provided in **Attachment 2**.

3 Stakeholders Analysis

3.1 Approach to Analysis

The analysis of stakeholders has been undertaken with a focus on understanding stakeholder values, understanding concerns and opportunities arising from the Project, and understanding potential impacts, risks, and levels of interest and influence. The intent of this initial analysis is to provide Santos with the foundation through which to inform the referral and continue engagement as the Project develops.

3.2 IAP2 Core Values

Stakeholder values are an important frame through which to understand what may be of importance. In accordance with the NT EPA stakeholder engagement and consultation guidelines, consultation will be guided by the principles of engagement, based on stakeholder level of interest and concern as outlined by the. The IAP2 core values for practicing public participation and community engagement are:

1. Public participation is based on the belief that those who are affected by a decision have a right to be involved in the decision-making process;
2. Public participation includes the promise that the public's contribution will influence the decision;
3. Public participation promotes sustainable decisions by recognising and communicating the needs and interests of all participants, including decision makers;
4. Public participation seeks out and facilitates the involvement of those potentially affected by or interested in a decision;
5. Public participation seeks input from participants in designing how they participate;
6. Public participation provides participants with the information they need to participate in a meaningful way; and
7. Public participation communicates to participants how their input affected the decision (IAP2 2014).

The purpose of these core values is to help make better decisions which reflect the interests and concerns of potentially affected people and entities (IAP2 2014).

3.3 Stakeholder Groups

Table 1-2 identifies the initial list of initial stakeholder groups considered as part of the SEP. It is to be acknowledged that this is an initial list and as the SEP is implemented, further stakeholders and more specific stakeholder details will be added. A full list of potential stakeholders is in **Attachment 1.**

3.4 Level of Engagement

The Project consultation associated with the referral and subsequent phases of the Project will be in accordance with the IAP2 principles to determine the appropriate levels of engagement (IAP2 2015). As the Project progresses, the level of engagement will be identified and determined on a case-by-case basis and certain stakeholders may be involved and collaborate on aspects of the Project. Stakeholder engagement is an essential component in the process of assessing the Project’s social, economic and environmental impact.

For the purpose of managing the level of engagement with stakeholder, stakeholders have been grouped as follows:

+ Level 1: Landholders, Indigenous Stakeholders or Traditional Owners, surrounding tenure holders and Government;
+ Level 2: Key interest groups and local communities;
+ Level 3: General public, community and special interest groups, wider region and Territory - based organisations.
+ Approaches or requirements that must be implemented due to statutory obligations and regulatory requirements.

Table 3-1 provides the IAP2 spectrum’s level of engagement and Santos’ relevant approach at each level. For Level 3 stakeholders the level of participation for this Project is anticipated to be inform and consult, for Level 2 stakeholders inform, consult and involve, and for Level 1 stakeholders, collaboration is anticipated.

The stakeholders’ ability to influence decisions depends on the decision type and what aspects of the Project are negotiable and what aspects are non-negotiable (IAP2 2015). The process is intended to be flexible and open to including relevant stakeholders to the maximum extent possible, while maintaining focus on targeted engagement where it makes sense.

Table 3-1 IAP2 Levels of Engagement

Level of Engagement	Stakeholder Level	Approach to the Community and Stakeholders
Inform	1, 2 and 3	Santos will aim to keep stakeholders informed
Consult	1, 2 and 3	Santos will keep stakeholders informed, listen to and acknowledge concerns and aspirations, and provide feedback on how stakeholder input influenced the decision.
Involve	1 and 2	Santos will work with stakeholders to ensure that their concerns and aspirations are directly reflected in the assessment completed and control measures employed and provide feedback on how stakeholder input influenced decision.
Collaborate	1	Santos will look to stakeholders for advice and innovation in formulating solutions and incorporate their advice and recommendations into the decisions to the maximum extent possible.
Empower	1	Santos will implement relevant stakeholder decisions where appropriate and feasible.

Amended from IAP2 2015

3.5 Identification of Potential Concerns and Opportunities

Potential concerns and opportunities that may be experienced by stakeholders during the lifecycle of the project have been outlined in Table 3-2 below. The purpose of this identification is to understand stakeholder perspectives on what may be of concern to them regarding the project so that Santos can understand potential impacts to stakeholders and what may trigger potential risks.

Understanding stakeholder concerns and their view regarding potential impacts (both actual and perceived) means that Santos can tailor why and how it engages with stakeholders and control the key messages that are communicated. This is also critical to understanding potential stakeholder risks, which in many cases are driven by perceptions stakeholders have of things that are important to them and may often be emotive and subjective. Often these perceptions may not be 'actual impacts' or supported by technical studies but it is critical to understand these.

Table 3-2 is an initial identification of potential concerns and opportunities and as such must be re-visited once Santos has undertaken more detailed engagement with stakeholders during the life of the Project. It is important that as part of this, environmental concerns and opportunities are identified as these are often key areas of interest for stakeholders. Although this SEP is focused on the pre-construction lifecycle phase, potential concerns and opportunities have been identified across the project lifecycle as these perceptions and potential impacts will influence how stakeholders need to be engaged from the beginning of the project.

Table 3-2 Potential concerns and opportunities that may be experienced by stakeholders during the project life-cycle

Project Phase	Potential concerns (perceived or actual)	Potential opportunities (perceived or actual)
Pre-construction (includes approvals)	+ Potential contamination of water or land from access for surveys + Potential introduction of invasive species from access for surveys + Potential direct mortality of fauna from vessel access + Potential to disturb unidentified Indigenous and non-Indigenous cultural heritage items through initial surveys and investigations + Potential for minor rubbish from initial investigative surveys and site investigations	+ Surveys build understanding of activities likely to be impacting greater regional environment + Build understanding of the fauna condition and habitat values + Protection of fauna habitat due to any offsetting + Increased training and employment opportunities improving capabilities and skills in local and regional areas + Increase in the local and regional socio-economic conditions + Opportunities for local suppliers and contractors + Employment and business opportunities for Indigenous community members
Construction (construction of the Project)	+ Potential water quality impacts, resulting from disturbance, accidental pollutant and contaminant releases + Exposure of soil to erosive factors during earthworks + Potential contamination of water or land through contaminant release (e.g. diesel leakage) + Site clearance and resulting environmental impact + Disturbance to habitat connectivity + Excessive noise during construction potentially leading to species fragmentation + Artificial light spill on the environment potentially disturbing and altering behaviour of a range of species	+ Data from monitoring health of water resources during construction + Greater understanding of ecological environment due to any ongoing Project investigations + Management and protection of fauna habitat + Increased training and employment opportunities improving capabilities and skills in local and regional areas + Increase in the local and regional socio-economic conditions + Opportunities for local suppliers and contractors

Project Phase	Potential concerns (perceived or actual)	Potential opportunities (perceived or actual)
	+ Visual amenity impacts + Potential for inappropriate behaviour of contractors and employees + Potential disturbance of unidentified Indigenous and non-Indigenous cultural heritage items (despite cultural heritage clearance)	+ Employment and business opportunities for Indigenous community members + Protection of any identified items of cultural heritage significance
Operations (operations of the Project)	+ Potential water quality impacts, resulting from watercourse disturbance, accidental pollutant and contaminant releases + Potential contamination through contaminant release (e.g. diesel leakage) + Disturbance to habitat connectivity + Potential spread and introduction of weeds during operation + Potential fire as a result of operations leading to destruction of habitat + Site clearance and resulting environmental impact + Potential for inappropriate behaviour of contractors and employees + Potential disturbance of unidentified Indigenous and non-Indigenous cultural heritage items (despite cultural heritage clearance) + Potential increase in local waste volumes during operation + Potential water and land contamination	+ Management and protection of remaining flora on site + Greater understanding of ecological environment due to any ongoing Project investigations + Management and protection of fauna habitat remaining on site + Potential to provide visual amenity management measures + Increased training and employment opportunities improving capabilities and skills in local and regional areas + Increase in the local and regional socio-economic conditions + Opportunities for local suppliers and contractors + Employment and business opportunities for Indigenous community members + Protection of any identified items of cultural heritage significance
Decommissioning	+ Loss of jobs and employment	+ Rehabilitation of the Project site and habitat + Potential re-use of Project components

3.6 Level of Engagement and Activities

Based on the analysis above, the following levels of engagement have been identified for stakeholder groups. These levels are based on the principle that engagement will be tailored by considering levels of stakeholder impact, interest and influence, and risk – with the assumption that the higher the level of impact and risk – the deeper the level of engagement required. This approach needs be flexible based on each specific stakeholder group and potential changes in stakeholder expectations and risk. Description of engagement levels and example activities are provided in Table 3-3.

Table 3-3 Different depths of engagement / communication

Level of engagement	Description	Example Activities
General	+ Generalised provision of project information and updates (this includes overview of potential impacts and mitigation / management strategies) + Opportunities to provide feedback through general activities and communication mechanisms (e.g. via website, email, as part of statutory consultation approach) + Audience: all stakeholders have access to information and activities	+ Website + Project information sessions + Media releases + Public consultation process
Targeted	+ Targeted engagement and communications specific to stakeholder group + Targeted engagement and communication activities designed to gain specific feedback + Ongoing opportunities to provide feedback and discuss key project elements (e.g. how potential impacts to a specific value could be managed) + Audience: while information may or not be publicly available activities are targeted towards specific group of stakeholders and are generally not open to 'general public'	+ Targeted group briefings or presentations + Targeted group or individual meetings + Targeted information portal e.g. ICN + Access to all general activities
Individualised	+ Engagement and communications developed for needs and expectations of specific stakeholder + Focus on gaining specific feedback and input from individuals / small group of individuals + Information in the form it was provided only accessible to specific party with which it was shared e.g. while a Minister may be provided	+ One-on-one meetings focused on specific topic of interest for both parties + Negotiation of formal contract or partnership (e.g. supplier agreement) + Shared value definition workshop / partnership

Level of engagement	Description	Example Activities
	information about jobs etc. that is available to the public the content of the conversation will be confidential	regarding social investment + Personalised email / phone conversations
Regulatory	+ Ongoing interaction with the regulator. This will be tailored depending on agency roles + More structured and individualised engagement will occur with lead agency + Ongoing opportunities to provide feedback	+ Structured meetings and communication schedule with lead agency + One-on-one / group meetings as required + Ongoing email and phone communication as required

3.7 Monitoring and Evaluation

Santos will maintain a stakeholder management register to record external stakeholder interactions for the Project (pre-construction, construction, operation). It is important that this register is updated by all team members following engagement activities so these can be adequately monitored and any stakeholder concerns or opportunities followed up. This is particularly important for the approvals process as records of engagement activities need to be summarised and provided as part of approvals documents to demonstrate adequate engagement has been undertaken.

From a risk management perspective, this is also important for Santos as/if issues arise there is a formal record of engagement that has been undertaken, and how these issues have been closed out as appropriate. If Santos undertakes broader sustainability reporting at a corporate level, these types of records can also be drawn on to align with Corporate.

With regards to monitoring the effectiveness of this plan, the implementation shall be reviewed quarterly. The plan should be revised, including the stakeholder analysis, prior to the commencement of each Project stage to incorporate lessons learned, stakeholder feedback and evolving issues, opportunities and risks that may have arisen.

Any review should consider the following:

+ Feedback from the regulator, external stakeholders, Santos employees and contractors;
+ Any complaints or findings from audit, review and inspections;
+ The outcomes of any incidents and how they can be managed / mitigated in the future;
+ Changes in Santos organisation structures, roles and responsibilities; and
+ Changes in regulation and guidelines that may impact engagement expectations of the regulator and community.

4 Community and Stakeholder Consultation Program

The following consultation program establishes the activities to be undertaken and key project milestones. All consultation activities undertaken for the Project are provided in the register located in **Attachment 2**.

Table 4-1 Consultation Phases

Stage	Description	Activities	Progress
Pre-Referral Stage	+ Initial regulatory engagement to outline the project and confirm necessary inclusions in the assessment; and + Early engagement with government, councils and port users regarding proposal.	+ Communication via email, phone etc. + One-on-one meetings	Complete
Post-Referral Stage	+ Activities to improve general stakeholder awareness of the project and avenues for providing input; + Targeted engagement and communications specific to stakeholder groups; + Targeted engagement and communication activities designed to gain specific feedback from the Referral.	+ Communication via email, phone etc. + One-on-one meetings + Technical meetings and briefings + Website (General) + Media releases (General)	Pending
Notification of Approval and Conditions	+ Update the Stakeholder Engagement Plan as necessary; + Undertake activities to inform stakeholders of the approval and conditions; and + Provide information to stakeholders on the next steps and project schedule.	+ Communication via email, phone etc. + One-on-one meetings + Website (General)	Pending
Construction Stage	+ Update the Stakeholder Engagement Plan as necessary; and + Early notification to key potentially affected stakeholders (e.g. local community) of project construction commencement and actions being implemented to manage risks; and + Undertake stakeholder and community engagement as required to satisfy approval conditions and achieve compliance with statutory obligations for construction.	+ Communication via email, phone etc. + One-on-one meetings + Website (General)	Pending

Stage	Description	Activities	Progress
	+ Provide general awareness of the avenues for stakeholder complaints.		
Operational Stage	+ Update the Stakeholder Engagement Plan as necessary; and + Undertake stakeholder and community engagement as required to satisfy approval conditions and achieve compliance with statutory obligations for the operation; + Undertake activities to maintain community and stakeholder awareness regarding avenues for project information and complaints.	+ Communication via email, phone etc. + One-on-one meetings + Website (General)	Pending
Decommissioning	+ Update the Stakeholder Engagement Plan as necessary; and + Notification of closure of the facility to relevant stakeholders; + Inform local and regional community of ongoing site management following closure.	+ Communication via email, phone etc. + One-on-one meetings + Website (General)	Pending

5 References

International Association for Public Participation (IAP2) 2015 Quality Assurance Standard for Community and Stakeholder Engagement, viewed 21 October 2021, Available: International Association for Public Participation Australasia, https://www.iap2.org.au/Tenant/C0000004/00000001/files/IAP2_Quality_Assurance_Standard_2015.pdf

IAP2 2014, Public Participation Spectrum, viewed 21 October 2021, Available: https://www.iap2.org.au/Tenant/C0000004/00000001/files/IAP2_Public_Participation_Spectrum.pdf

International Finance Corporation 2007, Stakeholder Engagement: A Good Practice Handbook for Companies Doing Business in Emerging Markets, May 2007, Washington, USA.

Northern Territory Environment Protection Authority (NT EPA 2021a), Preparing an Environmental Impact Statement (EIS) – Environmental impact assessment guidance for proponents, viewed 21 October 2021, Available: https://ntepa.nt.gov.au/__data/assets/pdf_file/0009/818217/preparing-an-environmental-impact-statements.pdf.

NT EPA 2021b, Stakeholder Engagement and Consultation – Environmental impact assessment guidance for proponents, viewed 21 October 2021, Available: https://ntepa.nt.gov.au/__data/assets/pdf_file/0005/884696/guidance-proponents-stakeholder-engagement-and-consultation.pdf.

Attachment 1 Stakeholder List

Stakeholder
Community groups
Amateur Fishermen's Association of NT (AFANT)
Australian Marine Conservation Society, NT
Australian Marine Science Association, NT
Charles Darwin University
Community members who reside or work in the greater Darwin area or surrounding region
Darwin Harbour Advisory Committee
Environment Centre, NT
Sea Turtle Foundation
Indigenous groups
Aboriginal Areas Protection Authority
NAILSMA
Northern Land Council
Tiwi Land Council (NT)
Wickham Deed Reference Group
Commonwealth Government
Australian Fisheries Management Authority
Australian Hydrographic Office
Australian Maritime Safety Authority
Australian Communications and Media Authority
Department of Agriculture, Water & Environment
Department of Defence
Department of Industry, Science & Resources
Director of National Parks
HMAS Coonawarra Naval Base
NOPTA
NOPSEMA
Northern Territory Government

Department of Chief Minister and Cabinet
Department of Environment, Parks & Water Security
Department of Infrastructure, Planning & Logistics
Department of Industry, Tourism & Trade (Fisheries)
Department of Industry, Tourism & Trade (Energy)
Environment Protection Authority (personnel)
Environment Protection Authority (Board)
Member for Arafura
NT Environment Protection Authority
Northern Territory Police, Fire and Emergency Services
NT Worksafe
Industry – Commercial Fishing
A. Raptis & Sons Pty Ltd (WA)
Aquarium Fishery License Holders (NT)
Austfish Pty Ltd (WA)
Austral Fisheries Pty Ltd (WA)
Australia Bay Seafoods (WA)
Coastal Line Fishery Licence-holders
Demersal Fishery License Holders (NT and WA)
Monsoon Aquatics (NT)
Northern Prawn Fishing Industry Pty Ltd (NPF)
Northern Prawn Fishery Licence-holders
Northern Territory Seafood Council (NTSC)
Northern Wildcatch Seafood Australia (WA)
Offshore Net and Line Fishery License Holders (NT)
Paspaley Pearling Company (NT)
Pearl Oyster Fishery License Holders (NT and WA)
Pearl Producers Association
Spanish Mackerel Fishery License Holders (NT)
WA Seafoods
Industry - Other

Arafura Bluewater Charters (NT)
Australian Marine Oil Spill Centre
Chamber of Commerce, NT
Darwin Port
Darwin Port Users Group
ENI Australia
ICN Network NT
INPEX
NT Guided Fishing Industry Association
NT Tourism
Oil Spill Response Ltd
Sea Darwin
SK E&S
Sun Cable
Top End Fishing
Territory and Federal Politicians
The Hon. Michael Patrick Francis Gunner MLA, Chief Minister
The Hon. Nicole Susan Manison MLA, Deputy Chief Minister
The Hon. Natasha Kate Fyles MLA, multiple ministerial titles
The Hon. Eva Dina Lawler MLA, multiple ministerial titles
The Hon. Lauran Jane Moss MLA, multiple ministerial titles
The Hon. Selena Jane Malijarri Uibo MLA, multiple ministerial titles
The Hon. Paul Andrew Kirby MLA, multiple ministerial titles
The Hon. Kate Jane Worden MLA, multiple ministerial titles
The Hon. Chanston James Paech MLA, multiple ministerial titles
The Hon. Warren Snowdon MP, Federal Member for Lingiari
The Hon. Sussan Ley MP, Federal Minister for the Environment

Attachment 2 Consultation Register

The following is a list of the main consultation undertaken to date with key stakeholders to inform preparation of the NT-EPA Referral prior to its submittal. A summary of the key themes of issues/concerns discussed to date is included in the NT EPA Referral.

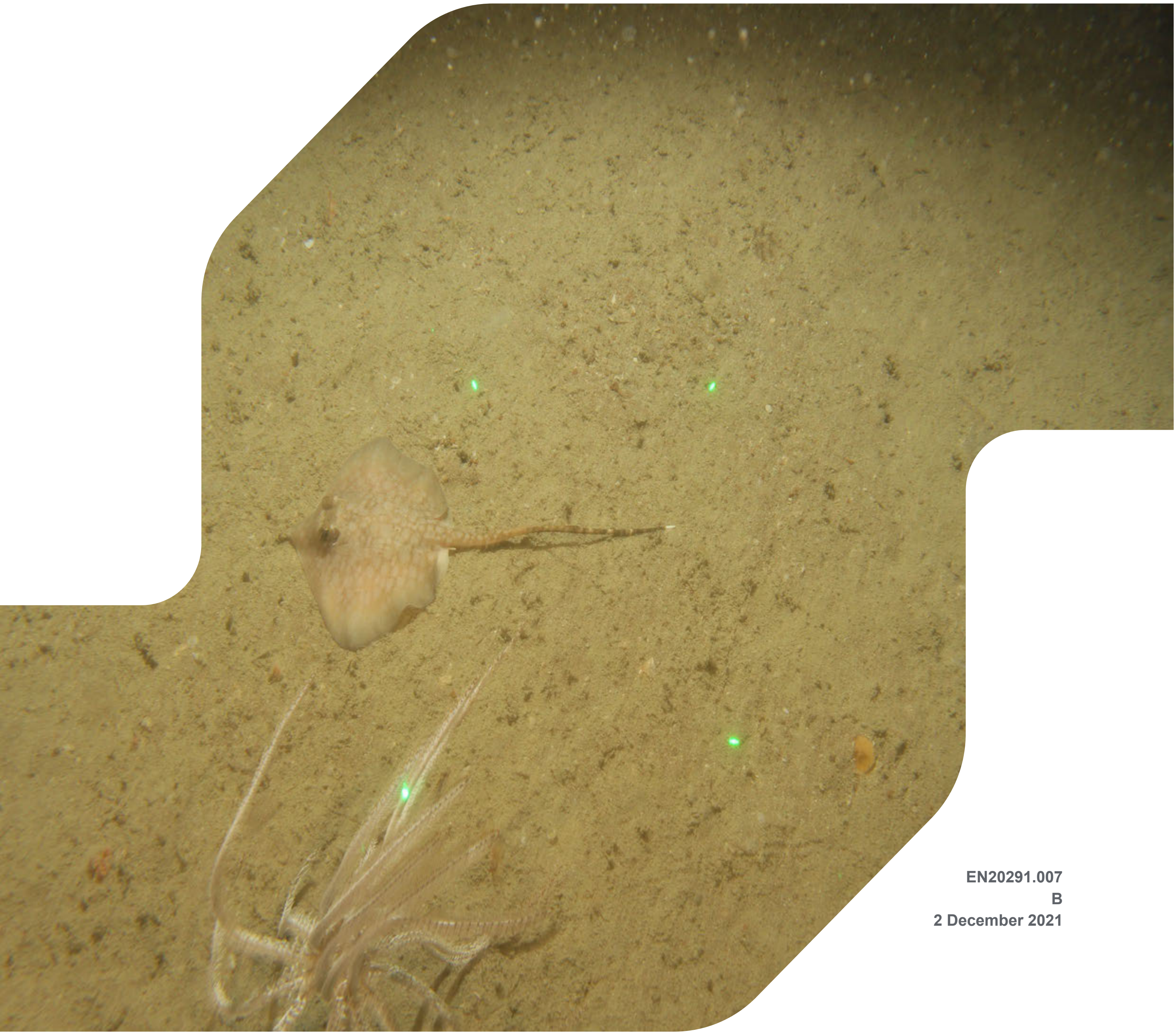
Stakeholder	Date	Description of Engagement
ALL	8 October 2021	Distribution of project update
Tiwi Land Council executive	19 October 2021	Meeting
Darwin LNG	20 October 2021	Meeting
Australia Bay Seafoods	20 October 2021	Meeting
NT Department of Environment, Parks & Water Services	21 October 2021	Meeting
NT DITT - Fisheries	21 October 2021	Meeting
NT Guided Fishing Industry Association	21 October 2021	Meeting
NT DITT - Energy	22 October 2021	Meeting
Darwin Port	22 October 2021	Meeting
Northern Prawn Fishery	25 October 2021	Meeting
NT DITT - Tenure	25 October 2021	Meeting
Sun Cable	25 October 2021	Meeting
Aboriginal Areas Protection Authority	26 October 2021	Meeting
Northern Land Council	26 October 2021	Meeting
NT Amateur Fishers Association	27 October 2021	Meeting
Tiwi Resources	27 October 2021	Meeting
NT Department of Infrastructure, Planning & Logistics (supports Darwin Harbour Advisory Committee)	4 November 2021	Meeting
NOPSEMA/NOPTA	5 November 2021	Meeting

Stakeholder	Date	Description of Engagement
Inpex	8 November 2021	Meeting
NT Heritage Commission	9 November 2021	Meeting
NT DITT-Energy	10 November 2021	Meeting #2
NT-DEPWS	17 November 2021	Meeting #2
HMAS Coonawarra Naval Base	17 November 2021	Meeting
Environment Centre NT (ECNT)	17 November 2021	Meeting
NT-DIPL	18 November 2021	Meeting #2
Wickham Deed Reference Group (Larrakia via DLNG)	19 November 2021	Meeting
Tiwi land owner groups	23, 25 November 2021	Meetings via zoom
Sea Darwin	24 November 2021	Phone
Aboriginal Areas Protection Authority Board meeting	2 December	Presentation
EPA Board	7 December 2021	Presentation
Darwin Harbour Advisory Committee	16 December 2021	Presentation

Appendix D – Environmental Baseline Survey – Interim Field Report

SANTOS BAROSSA DPD

Interim Field Report #2



EN20291.007
B
2 December 2021

Document status

Version	Purpose of document	Authored by	Reviewed by	Approved by	Review date
Rev A	Draft for internal review	NatRob	JerFit	[Text]	5/11/2021
Rev B	Draft interim report for referral	NatRob	GarHoo		2/12/21

Approval for issue

[Name]	[Signature]	[Date]

Prepared by:

RPS

Natalie Robson
Marine Environmental Scientist

Level 2, 27-31 Troode Street
West Perth WA 6005

T +61 8 9211 1111
E natalie.robson@rpsgroup.com.au

Prepared for:

Santos Limited

Nick Phillips
HSE Team Lead Barossa Project

53 Ord Street
West Perth WA 6005

E Nick.Phillips@Santos.com

Contents

Tables

Plates

Figures

1 INTRODUCTION

Santos is exploring options for the Darwin Pipeline Duplication (DPD) Project associated with development of the Barossa gas field in northern Australia. The pipeline would run from the point where the Barossa gas export pipeline (GEP) intersects the existing Bayu-Undan (BU) pipeline (kilometre point (KP) 0), running alongside the existing BU GEP into Darwin LNG plant at Wickham Point in Darwin Harbour (KP122.2). The pipeline would be trenched using a dredge in areas within the harbour and then laid on the seabed in offshore outside of the harbour. Dredge spoil will be placed at an offshore dredge spoil disposal site adjacent the existing INPEX spoil ground outside the harbour in Northern Territory waters. Seabed material sourced from sand waves at the mouth of Darwin Harbour will be used to backfill the trench once the pipeline has been laid. These activities have potential to cause environmental impacts which must be identified, quantified, mitigated, and managed to acceptable levels.

In support of environmental approvals for the DPD project, Santos has developed a team of consultants to deliver environmental approvals, baseline studies, management plans and discharge modelling. RPS was engaged to conduct the baseline environmental survey for the project, designed to fill gaps in the existing dataset. Sampling sites were selected partly to ensure representation of the different sections of the pipeline route and partly to investigate features identified from preliminary interpretation of geophysical data recently collected along the pipeline route by Fugro.

The baseline survey included the following areas:

- The pipeline route from KP0 (equivalent to Bayu-Undan pipeline kilometre point (KP) 380) to ~KP91 (Darwin Harbour port boundary)
- The proposed spoil ground
- The pipeline route within Darwin Harbour (KP91 to KP122).

1.1 Objectives

The Barossa DPD offshore survey objectives were to:

- Undertake water quality, sediment quality and benthic habitat and communities assessments along the proposed pipeline route and at the spoil ground.
- Identify any areas of higher environmental value or sensitivity to inform the Environmental Impact Assessment (EIA) for the project.

1.2 Purpose

The purpose of this field survey report is to provide a summary of the field activities and results from the field surveys, including a brief description of the key features and benthic habitats along the pipeline route and at the spoil ground area. This document will be updated as further data, including laboratory analytical results, become available.

2 METHODS

2.1 Survey team and vessel

The survey was carried out on the Lauri J supplied and crewed by Bhagwan Marine. Fugro provided the survey Party Chief, navigation and deck operations support. RPS designed and conducted the sampling and collected the sediment and water samples and benthic imagery.

2.2 Sampling sites

The survey design was supplemented in the field with additional sites based on any potential features identified during the Fugro geophysical scope. The survey was divided into three sampling locations and the samples coded accordingly; the offshore pipeline (OP; KP0 and ~KP91), Darwin Harbour pipeline (HS; ~KP91 and KP122, including the sand wave dredge areas), and the spoil ground (SG; Figure 2-1). The sampling sites were based on historical geophysical data, and therefore considered representative of the full pipeline corridor, including the anchoring areas either side of the proposed pipeline route.

Table 2-1: Sample naming conventions for the Barossa DPD survey

Sample location	Sample type	Sample ID	Number of sites
Offshore pipeline	Sediment	OP	33
	Drop Video	OP	9
	Video Transect	V	17
	Surface water	OP S	10
	Bottom water	OP B	10
Spoil Ground	Sediment	SG	13
	Drop Video	SG	13
	Surface water	SG S	7
	Bottom water	SG B	7
Darwin Harbour	Sediment	HS	53
	Video Transect	HS	30

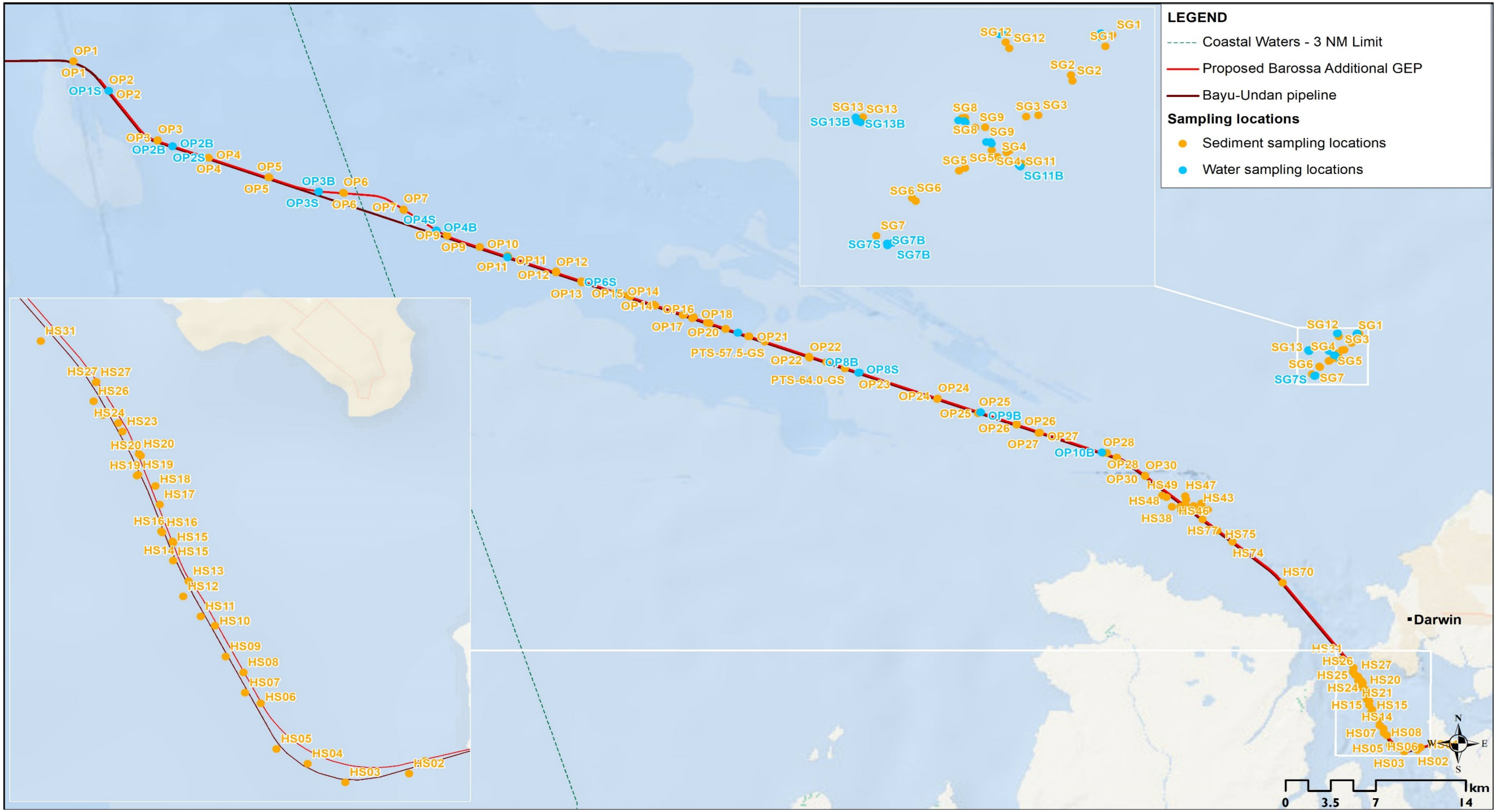


Figure 2-1: Sediment and water quality sites along the proposed Barossa pipeline route and Spoil Ground

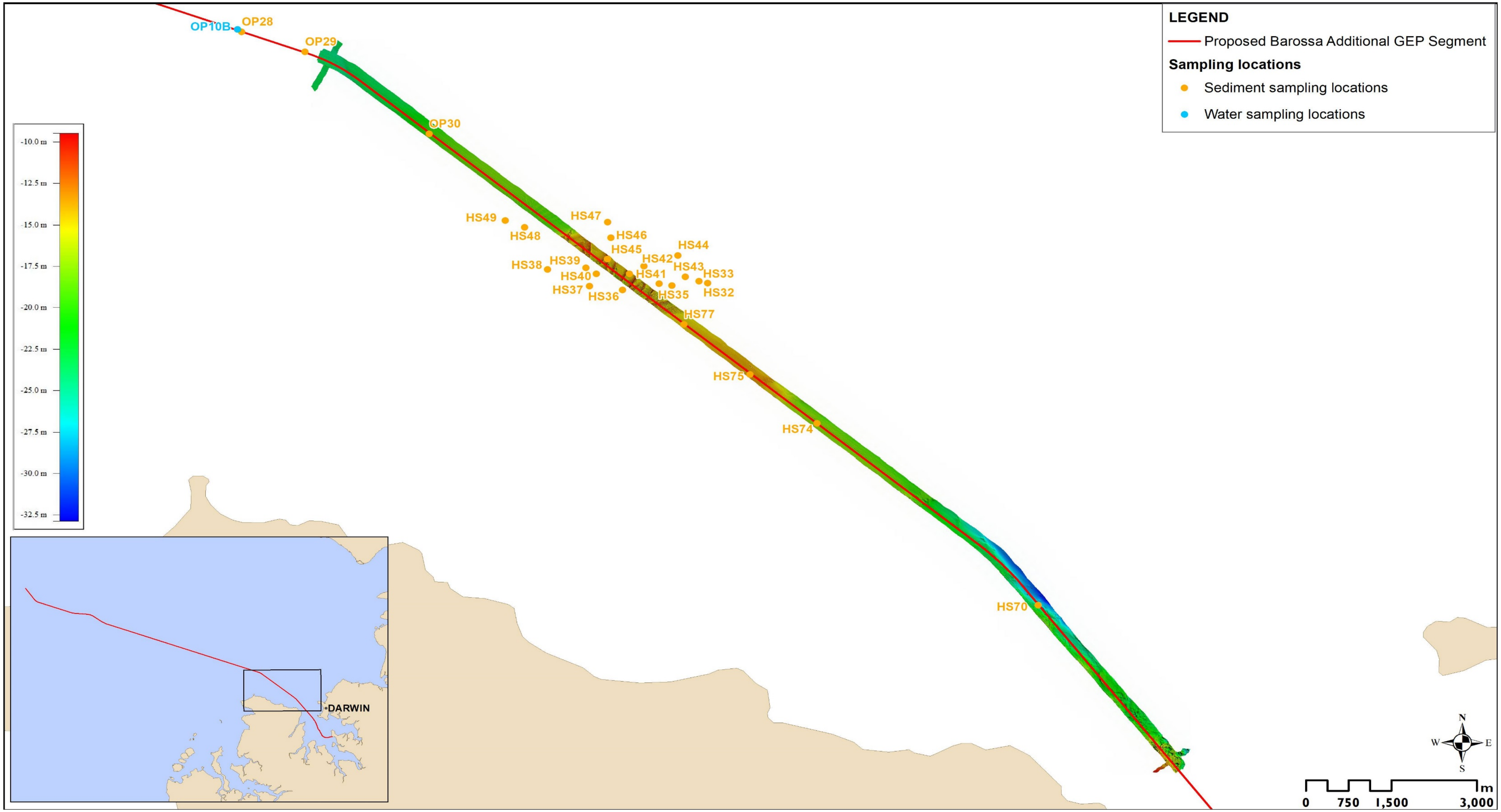


Figure 2-2: Darwin Harbour sediment sites and sand wave area, showing 2021 north multi-beam data

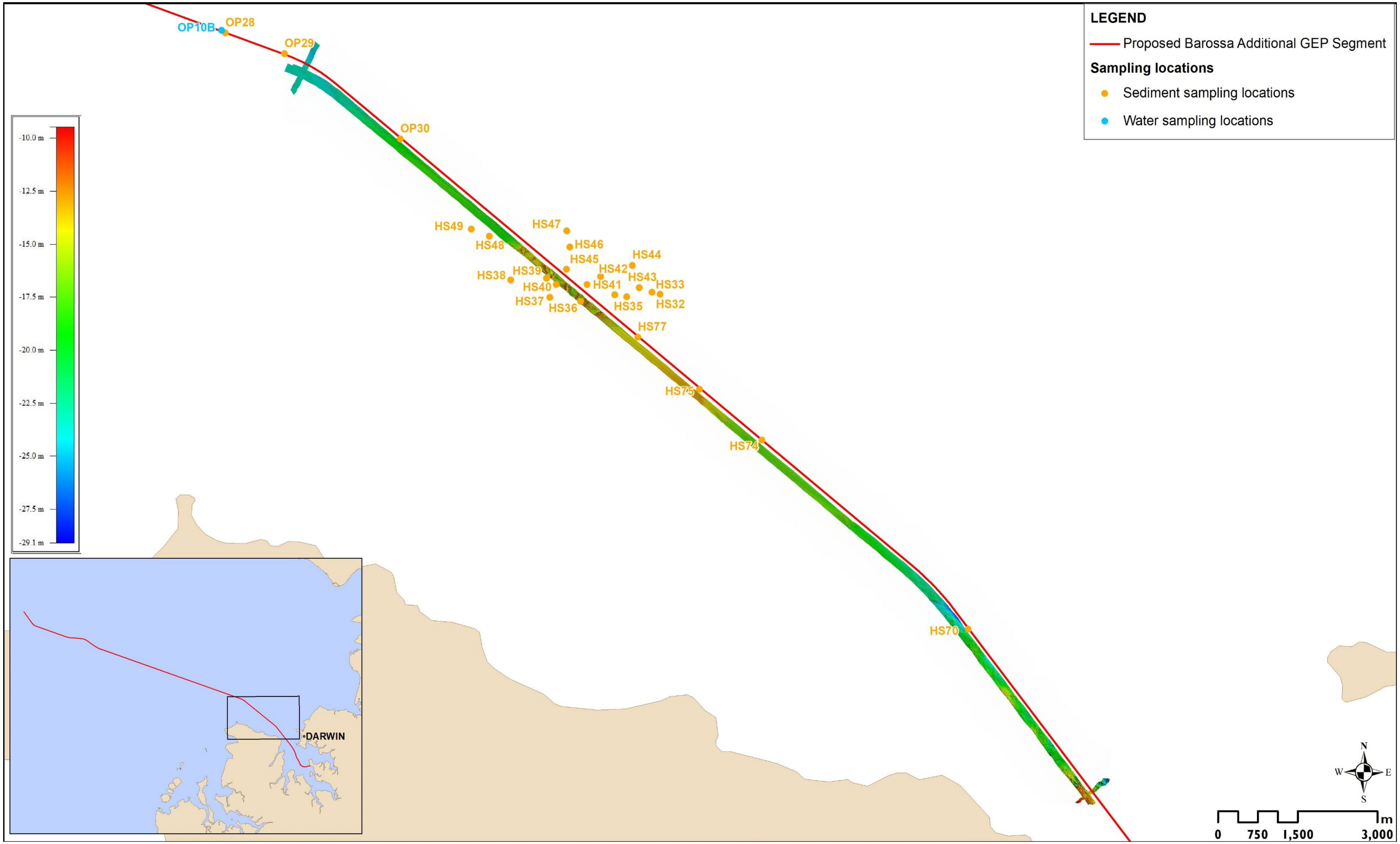


Figure 2-3: Darwin Harbour sediment sites and sand wave dredge area, showing 2021 south multi-beam data

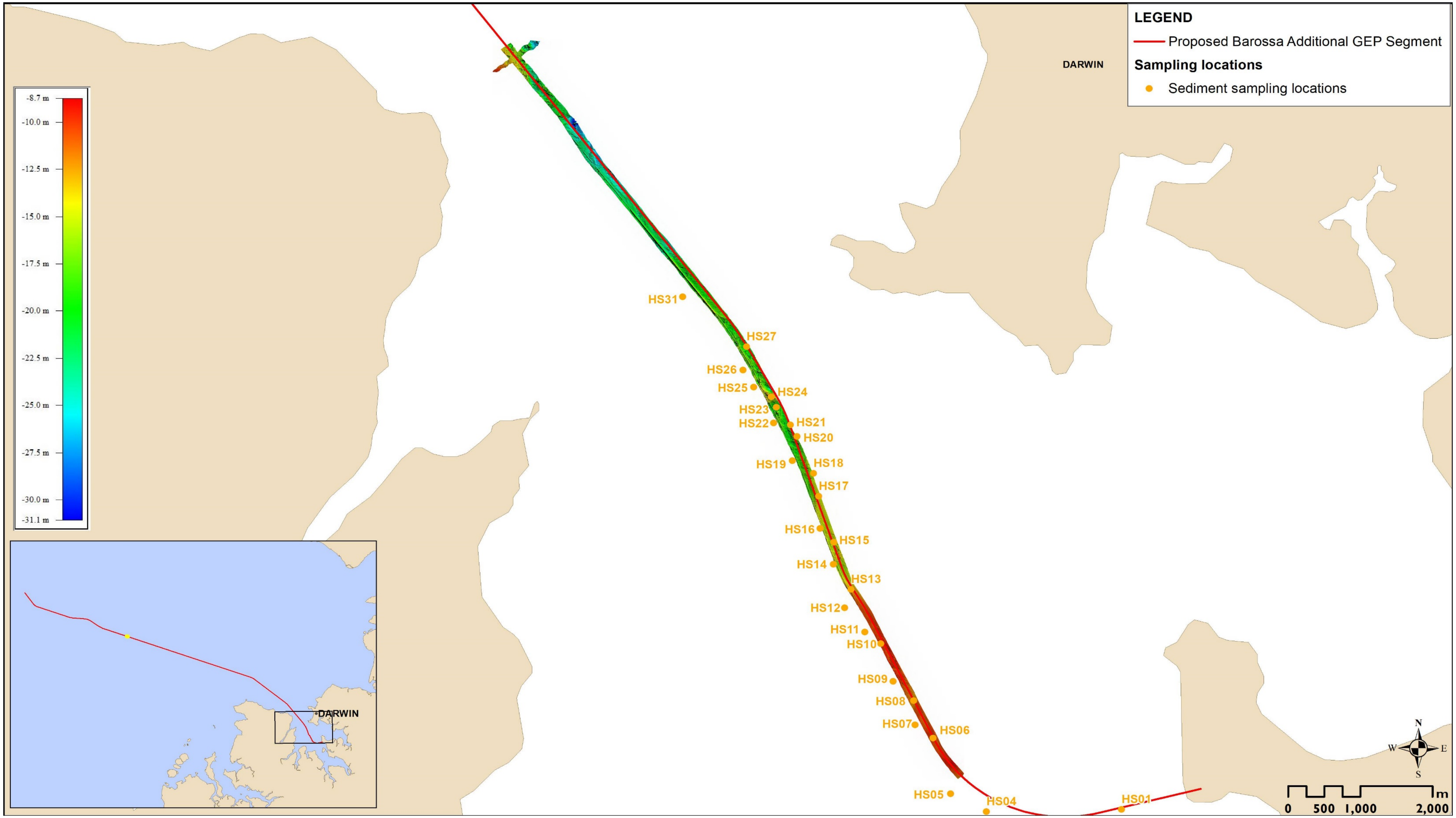


Figure 2-4: Darwin Harbour sediment sites, showing 2021 north multi-beam data

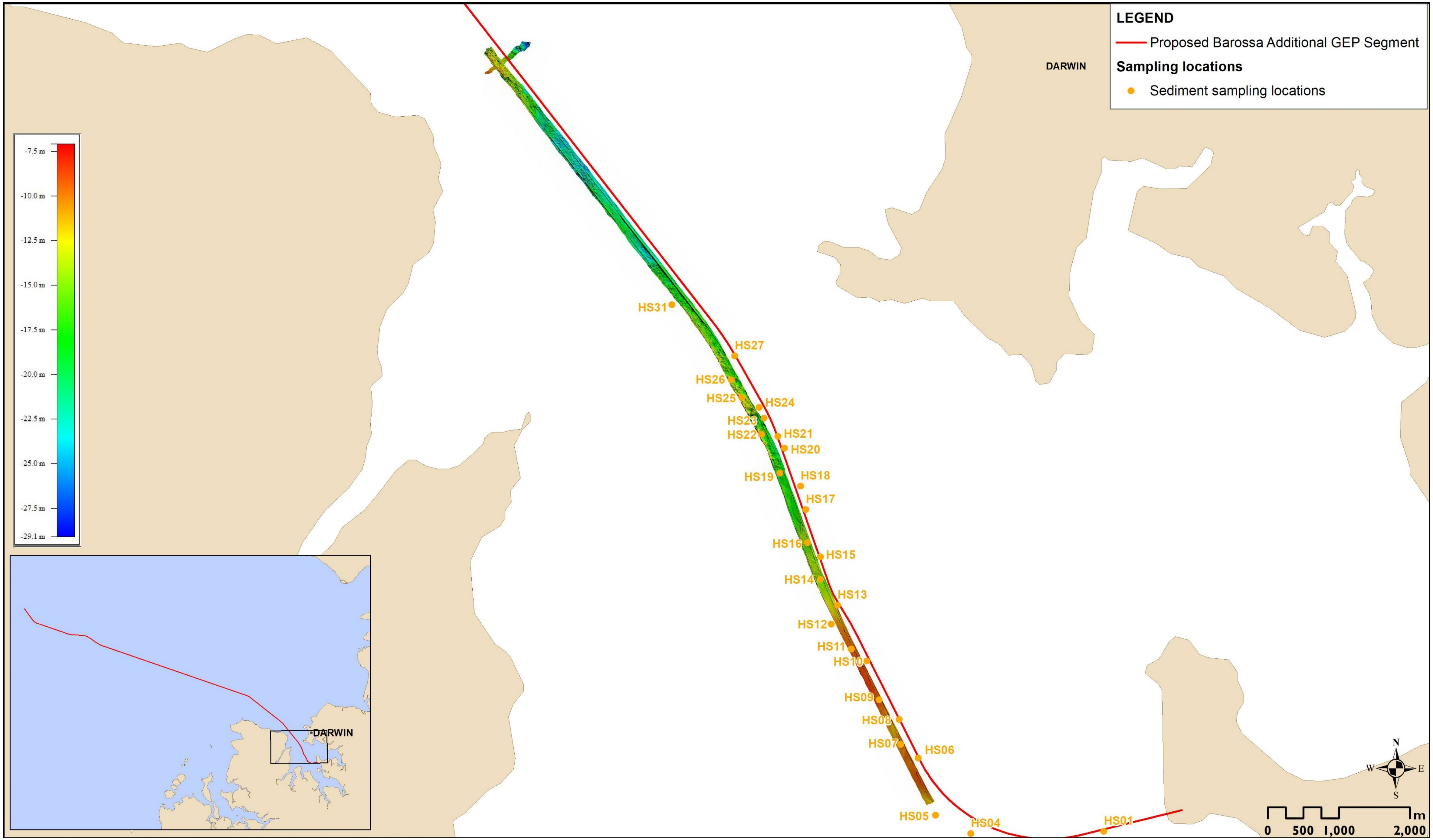


Figure 2-5: Darwin Harbour sediment sites, showing 2021 south multi-beam data

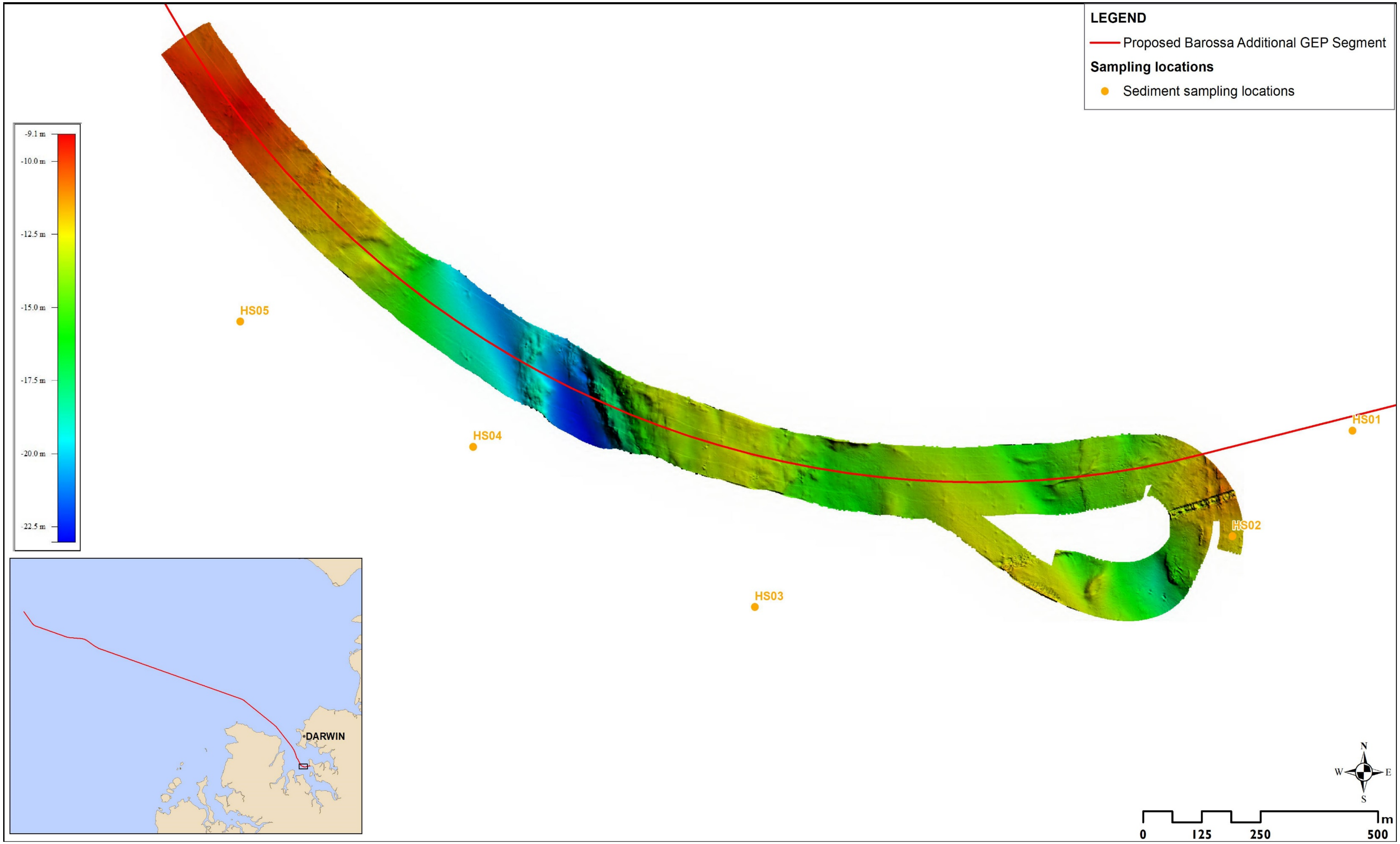


Figure 2-6: Darwin Harbour sediment sites close to the shore crossing, showing 2021 north multi-beam data

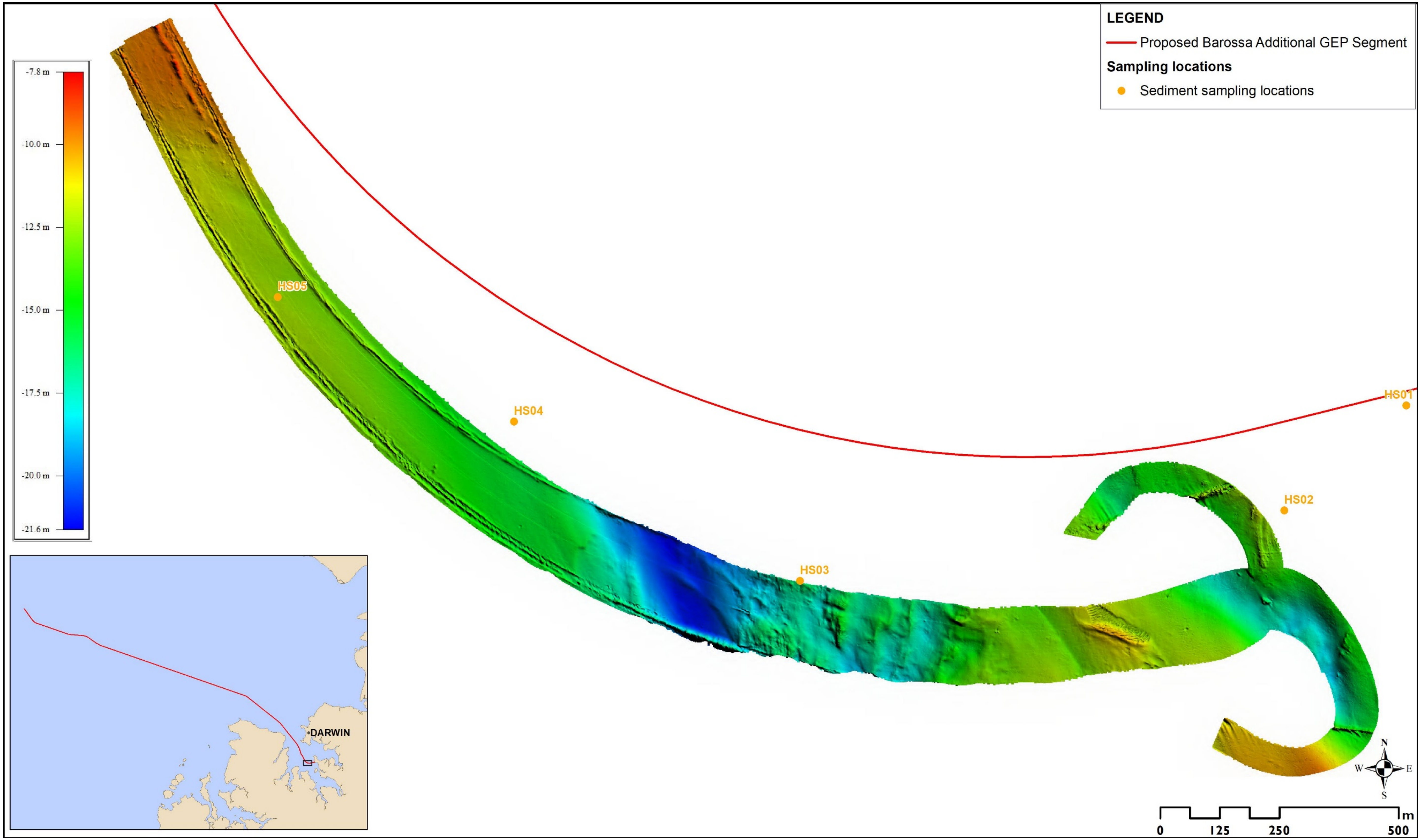


Figure 2-7: Darwin Harbour sediment sites close to the shore crossing, showing 2021 south multi-beam data

2.3 Subsea Video

An SeaSpyder subsea video system mounted on a drop camera frame was used to collect digital video and stills imagery (Plate 2-1). The colour video camera was fitted with a zoom lens controllable from the surface control unit and live imagery was transmitted to the control room on the vessel via a load-bearing umbilical. Imagery was also recorded for subsequent analysis. The system also comprised a stills camera, lighting system and lasers (spaced 20 cm apart).

The benthic habitats observed and recorded during each camera drop were described by RPS marine scientists. ESRI's ArcPad software was used to record the positional data for the tracklog of the towed video transect and the spot-point positions for each still image taken. During the video deployments, vessel speed did not exceed a speed of ~1.5 knots. The imagery collected will be analysed in detail by marine scientists at RPS to characterise topographic features, benthic habitats and macrofaunal communities.

The video system was deployed at a total of sixty-nine (69) sites across the pipeline route and spoil ground. Video site locations were initially based on positions of seabed features derived from the original Bayu-Undan geophysical survey data. Locations of interest were then identified in the field, using the 2021 Fugro geophysical survey data, and the video site locations and transects were adjusted accordingly.

Plate 2-1: The SeaSpyder camera system

2.4 Sediment Quality

2.4.1 Sample collection

Sediments were sampled at 30 offshore pipeline locations, with an additional three sampled for particle size distribution only at the request of Santos), 13 spoil ground locations and 53 Darwin Harbour pipeline locations (including the sand wave area). Samples were collected using a double van Veen grab mounted in a single frame (with a sampled surface area of each grab being 0.1 m^2), which was deployed and retrieved by Fugro personnel. An optimal sample processing area was identified as part of strict contamination risk management protocols. GPS position, depth, time and date were recorded every time the grab reached the seabed. Upon retrieval to deck, each sample was photographed with a video slate showing the project, site, sample number and date. Each sample was then characterised to document conspicuous biota, sediment types, presence of visible anoxic layers, hydrocarbons or anthropogenic material. If samples could not be obtained at the site (after 3 attempts), then the site was moved and sampled nearby (within 50 m).

2.4.1.1 Subsampling – sediment contaminants

Subsamples for contaminant samples were taken from the top 2 - 5 cm of grab samples - excluding surficial sediments within 5-10 mm of the sides of the grab (to reduce the risk of contamination). Sediment was removed using a stainless-steel scoop and placed in a glass bowl for mixing. All implements had been pre-cleaned with Decon-90.

Once homogenised, sediment was placed in the appropriate laboratory-supplied sample containers. The PSD sample was also taken from surficial sediments to allow direct comparison between contaminants and sediment grain sizes.

For all samples:

- Sterile gloves were worn at all times when collecting and processing samples. These were changed between samples
- The insides of sample lids did not come into contact with anything potentially contaminated
- Jars and bags were sealed, correct labelling confirmed, and then stored in an esky with ice blocks
- At the end of each shift, samples were stored as identified in Table 2-2.

2.4.1.2 Sampling- infauna

A full 0.1 m^2 van Veen grab sample was collected for infaunal assessment at each site. The infauna sample was carefully emptied into a fish tray and then placed into the infauna processing table (Plate 2-2). The sample was carefully washed using sea water from the deck hose, with the washings flowing out through the sluice gate and draining through a 1mm mesh sieve. The rate of flow through the sluice was managed by controlling the volume of water within the table, and the amount of water flowing through the sluice gate. The sieve was rotated or shuffled to prevent clogging. When the sieve was almost full, the sluice gate was shut to stop the flow, and the full sieve swapped out for an empty sieve. A puddling bin was used to remove as much remaining sediment as possible through the sieve. Samples were then carefully washed out into a plastic Ziplock bag and preserved with 100% ethanol (to a final concentration of ~80% in seawater).

Plate 2-2: Infauna filtering table set up on the Lauri-J

2.4.2 Offshore DPD and spoil ground

Sediment samples for contaminants, particle size distribution and infauna were collected from 33 pipeline sites (including the additional three PSD sites were added during the survey) and 13 spoil ground sites, (Table 2-2).

Table 2-2: Sediment quality sampling summary for Barossa offshore DPD and spoil ground sites

Sample	# of samples (Spoil Ground)	# of samples (DPD)	Total Samples	Laboratory	Lab LOR*	Container	Volume	Storage method	Holding time
Particle Size Distribution (PSD)	13	33	46	MAFRL	NA	Ziplock bag	250 ml	Freeze	5 years
Infauna	13	30	43	Benthic Australia	NA	Bucket	0.1 m^2	Ethanol	
Total Organic Carbon (TOC)	13	30	43	MAFRL	<0.1%	2 x plastic jars	70 ml	Freeze	1 month
Metals and metalloids (Al, Sb, As, Ca, Cr, Co, Cu, Fe, Pb, Mn, Hg, Ni, Ag, Zn)	13	30	43	MAFRL	Depends on metal- 0.01-2				
Nutrients (Total Phosphorous (TP))	13	30	43	MAFRL	<0.05				
Nutrients (Total Kjeldahl Nitrogen (TKN))	13	30	43	MAFRL	<0.1				
Total Recoverable Hydrocarbons (TRH) & Benzene, Toluene, Ethylbenene, Xylenes and Naphthalene (BTEXN)	13	30	43	ALS	0.2 - 5 mg/kg, 1 %	Glass Jar	150 ml	Cold	14 days
Polycyclic Aromatic Hydrocarbons (PAH; where TRHs are above limits of detection)	0	0	0	ALS	4 - 5 µg/kg			Cold	14 days
Naturally-Occuring Radioactive Materials (NORMS; $Radium^{226}$, $Radium^{228}$, $Thorium^{228}$)	13	30	43	SGS	3, 5, 3 Bq/kg	Zip-lock	250 ml	Freeze	1 month

*LoR = limit of reporting.

2.4.3 Darwin Harbour DPD

Sediment samples for contaminants and PSD were collected from 53 sites along the pipeline route in Darwin Harbour (Table 2-3).

Table 2-3: Sediment quality sampling summary for Darwin DPD sites

Sample	Total Samples	Laboratory	Lab LOR	Container	Volume	Storage method	Holding time
Particle Size Distribution (PSD)	53	MAFRL	NA	Ziplock bag	250 ml	Freeze	5 years
TBT	53	ALS	NA	Glass Jar	250 ml	Cold	14 Days
TOC	53	ALS	0.02 %	Glass Jar	250 ml	Cold	14 days
Metals and metalloids (Al, Sb, As, Ca, Cr, Co, Cu, Fe, Pb, Mn, Hg, Ni, Ag, Zn)			Depends on metal- 0.01-50				
Nutrients (TP)			2 mg/kg				
Nutrients (TKN)			20 mg/kg				
TRH & BTEXN			0.2 - 5 mg/kg, 1 %				
PAH (where TRH is above limits of reporting)	37		4 - 5 µg/kg				
Acid Sulphate Soils (ASS)	53	ALS	0.1 pH Unit, 1 -	Zip-lock	250 ml	Freeze	14 days
Organochlorine pesticides and Polychlorinated biphenyls	53	ALS	0.25 - 0.5 µg/kg 5 µg/kg	Glass Jar	250 ml	Cold	14 days
NORMS (Ra^{226}, Ra^{228}, Th^{228})	53	SGS	3, 5, 3 Bq/kg	Zip-lock	250 ml	Freeze	1 month

2.5 Water Quality

2.5.1.1 Water column profiling

Water column profiling was undertaken using a calibrated SeaBird SBE19plusV2 conductivity, temperature depth (CTD) profiler lowered through the water column at a rate of half a metre per second at each of the 17 water quality sampling locations. The maximum deployment depth (the position of the profiler above the seabed) was determined from the vessel echosounder prior to deployment. The following parameters were recorded in each profile:

- Pressure (to derive depth)
- Conductivity (to derive salinity)
- Temperature
- pH
- Dissolved oxygen
- Turbidity

The data was downloaded off the seabird after each profile.

2.5.1.2 Sample collection

Water samples were collected at the sea surface (1 to 5 m below sea level (BSL)) and near the seabed (5 m above seabed (ASB)) using 10 litre Niskin bottles.

Phytoplankton and total suspended solids (TSS) samples were collected by filtering a 3 L sample of water through a filter tower (Plate 2-3). Phytoplankton samples were collected through a 0.8-1.2 µm filter, whilst TSS samples were filtered through a pre-weighed filter (stored in an envelope until used). Each filter paper was folded into quarters and wrapped in a dry piece of filter paper and placed back in the envelope for storage. Filtered metal samples were drawn through filter using a syringe. These samples were then transferred to a small pre-labelled sample jar. All other samples were placed in pre-labelled containers.

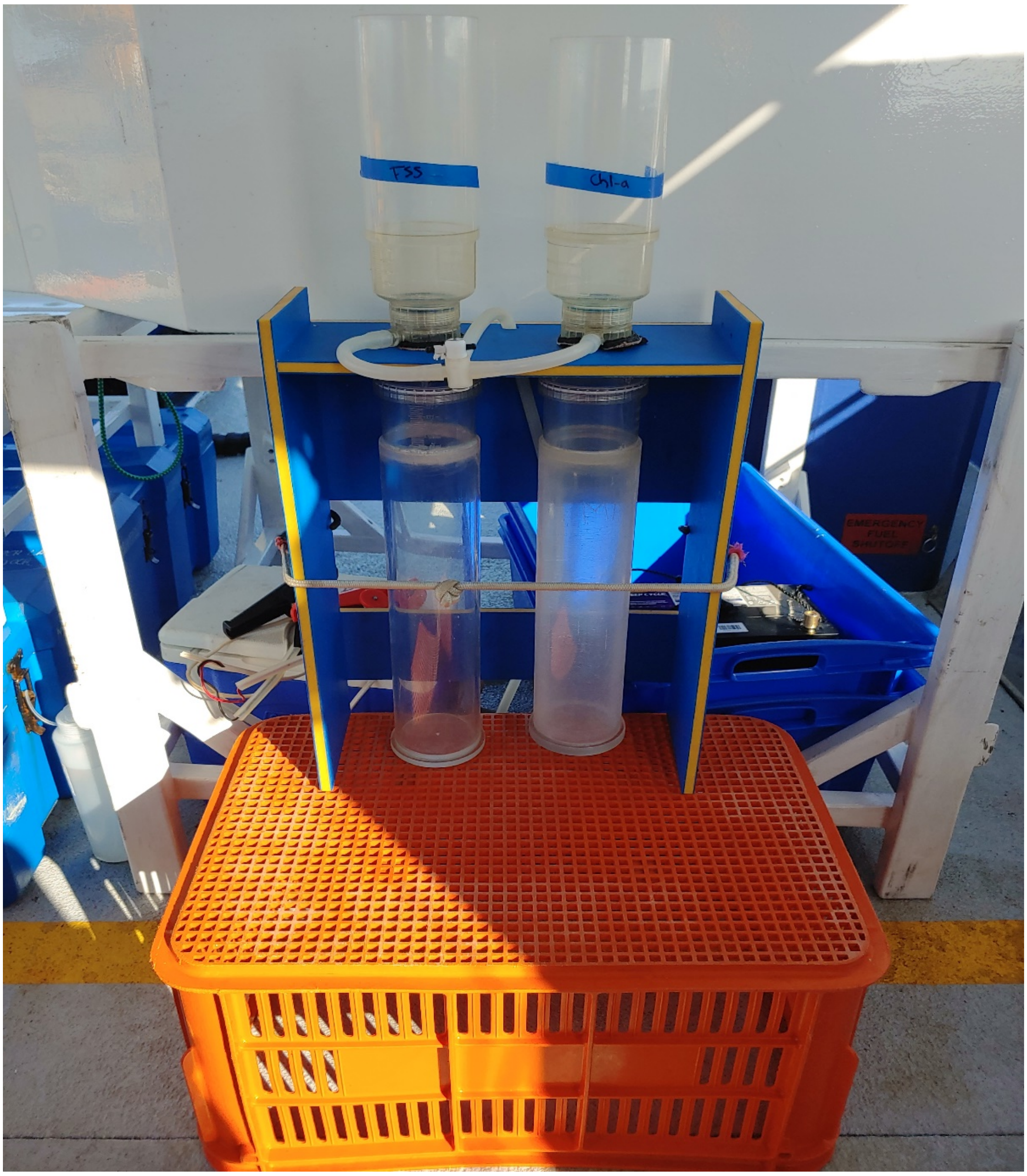


Plate 2-3: Water quality filtering station set up on the Lauri-J

Table 2-4: Water quality sampling requirements

Analyte	Sample # (Spoil Ground)	Sample # (Offshore)	Total Samples	Laboratory	Lab LOR	Container	Volume	Storage method	Holding time
TSS	14	20	34	MAFRL	1 mg/L	Filter paper placed in zip lock bag	NA	Cold	7 days
Nutrients (TP/ Total Nitrogen (TN))	14	20	34	MAFRL	5 µg.P/L/ 50µg.N/L	PP container	125 ml	Freeze	1 month
Orthophosphate	14	20	34	MAFRL	2 µg.P/L	PP tubes	10ml		
Nitrite and nitrate (NO_2 and NO_3)	14	20	34		2 µg.N/L				
Ammonium (NH_4+)	14	20	34		3 µg.N/L				
Phytoplankton pigments (Chlorophyll-a and Phaeophytin-a)	14	20	34	MAFRL	0.1 mg/L	Filter paper placed in zip lock bag	NA	Freeze (in dark)	1 month
Unfiltered Metals and metalloids (As, Ca, Cr, Co, Cu, Pb, Ni, Zn)	14	20	34	MAFRL	0.05-1µg/L	PP tube	10 ml	Cold	2 weeks
Unfiltered Hg	14	20	34	MAFRL	0.1µg/L	Dark bottles	125 ml	Cold	2 weeks
Filtered Metals and metalloids (As, Ca, Cr, Co, Cu, Hg, Pb, Ni, Zn)	14	20	34	MAFRL	0.05-1µg/L	PP container	125 ml	Cold	2 weeks
Filtered Hg	14	20	34	MAFRL	0.1µg/L	Dark bottles	125 ml	Cold	2 weeks
TRH & BTEXN	14	20	34	ALS	1 - 100 µg/L	Purple glass vials (Sulfuric Acid)	2 x 40 ml	Cold	1 week
PAH (where TRH above LORs)	0	0	0	ALS	0.5 - 1 µg/L	Orange glass bottle	100 ml	Cold	1 week
NORMS (Ra^{226}, Ra^{228}, Th^{228})	7	10	17	SGS	0.05,0.1,0.03 Bq/L	Plastic container	1000 ml	Nitric acid	6 months

2.6 Quality Assurance and Quality Control

Prior to sampling, the deck area was assessed for potential sources of contamination. Where there had been clear washout of the surficial sediments in grab samples (e.g. due to a shell or rock caught in the jaws of the grab) the sample was discarded and classed as a failed attempt. Similarly, if water from the winch wire was observed dripping into the sample, the sample was discarded as it was potentially contaminated by hydrocarbons from the winch.

RPS requires that laboratories use NATA-accredited methods and have a Quality Assurance and Quality Control (QA/QC) program, where possible. Pre-cleaned sample containers for chemical analyses were provided by the laboratories for this survey. The following control process were undertaken to quantify potential within-laboratory variability in analysis and any potential sample contamination that could have occurred during sample collection, handling, storage or transport. All samples were transported with relevant and fully completed Chain of Custody (CoC) documentation.

2.6.1 Triplicates/Duplicates

Triplicate sediment and water samples were collected at the offshore pipeline and spoil ground sites, while duplicates were collected within the Darwin Harbour sites, to determine potential within-laboratory variability in analyses. At least one triplicate or duplicate sample was collected for every twenty primary samples. Triplicates and duplicates were collected from the same bulk sediment sample as the primary sample and were labelled appropriately. The labelling code for triplicates allowed RPS to identify the collection site but it was not apparent to the laboratories.

2.6.2 Trip blanks

Trip blanks, or transport blanks, are used to assess potential contamination of samples during transport and storage. Trip blanks were supplied by the laboratory and consisted of plastic jars pre-filled with deionised water. They remained unopened during sampling. Rinsate water was used rather than inert sediment as it is considered to be a more sensitive test.

2.6.3 Field blanks

Field blanks detect contamination from sample handling, dust and other atmospheric fallout during the sampling process. Laboratory-supplied deionised water was decanted and stored in the same containers and in the same way as for the sediment samples and left open during sediment sampling. Water was used rather than inert sediment as it is considered to be a more sensitive test.

2.6.4 Equipment blanks

Equipment blanks measure contamination introduced through contact with sampling equipment. These may be taken depending on the condition of the equipment and potential for contamination. The samples were taken after the grab sampler had been decontaminated with Decon-90. After decontamination, the operator thoroughly rinsed the grab with seawater, then rinsed it again with the laboratory-supplied deionised water, which was captured in a laboratory-supplied sample container. This will detect potential contamination from the stainless-steel grab sampler.

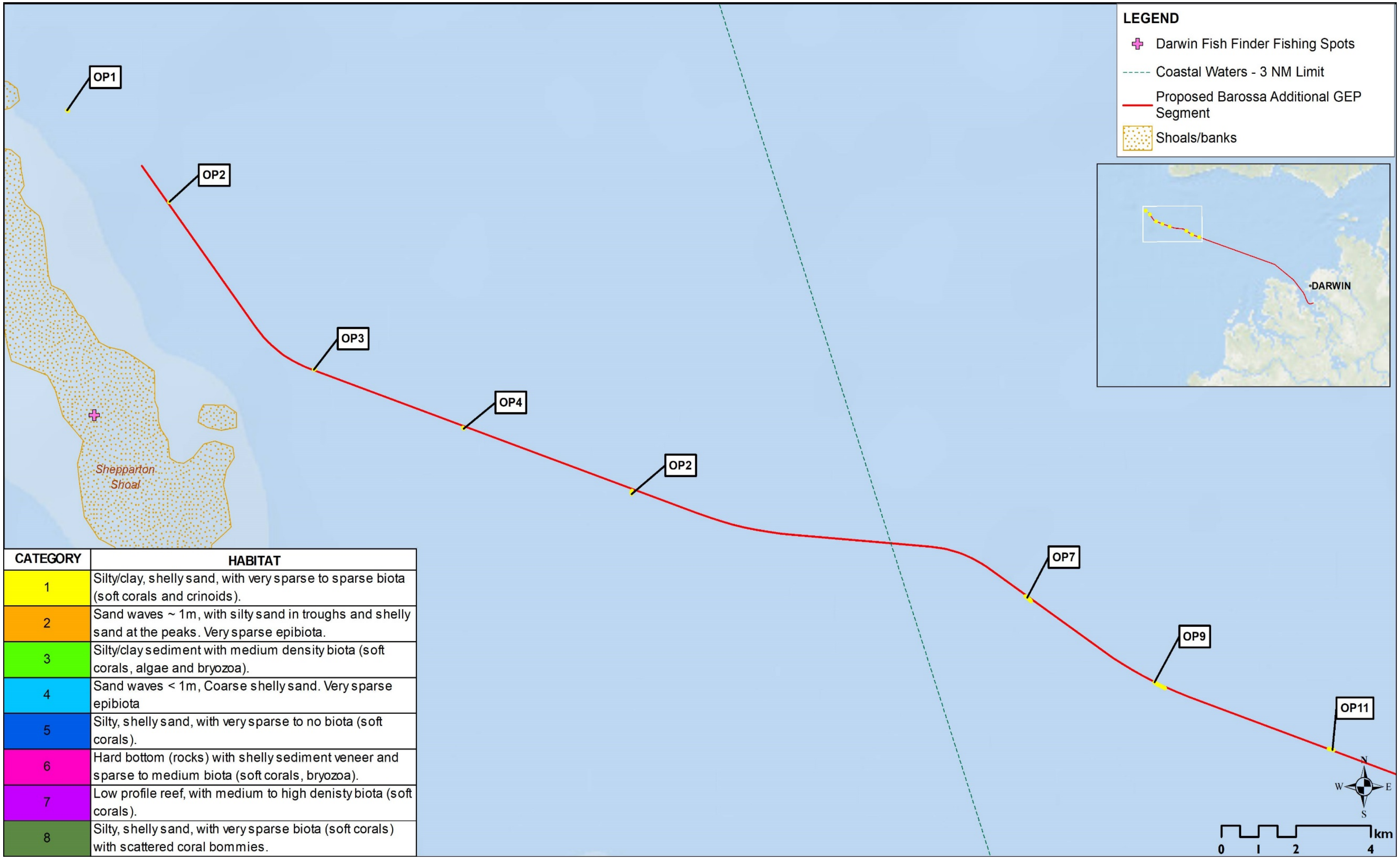
2.6.5 Sample preservation and storage

Water containers were filled to ~80% to leave a head-space sufficient to allow for expansion of the sample during freezing. During vessel demobilisation, samples were separated based on the laboratory they were being shipped to and transferred to clean eskies containing ice blocks for delivery to the laboratory. Chain of custody forms were filled out for each laboratory and sent with the relevant eskies.

3 RESULTS

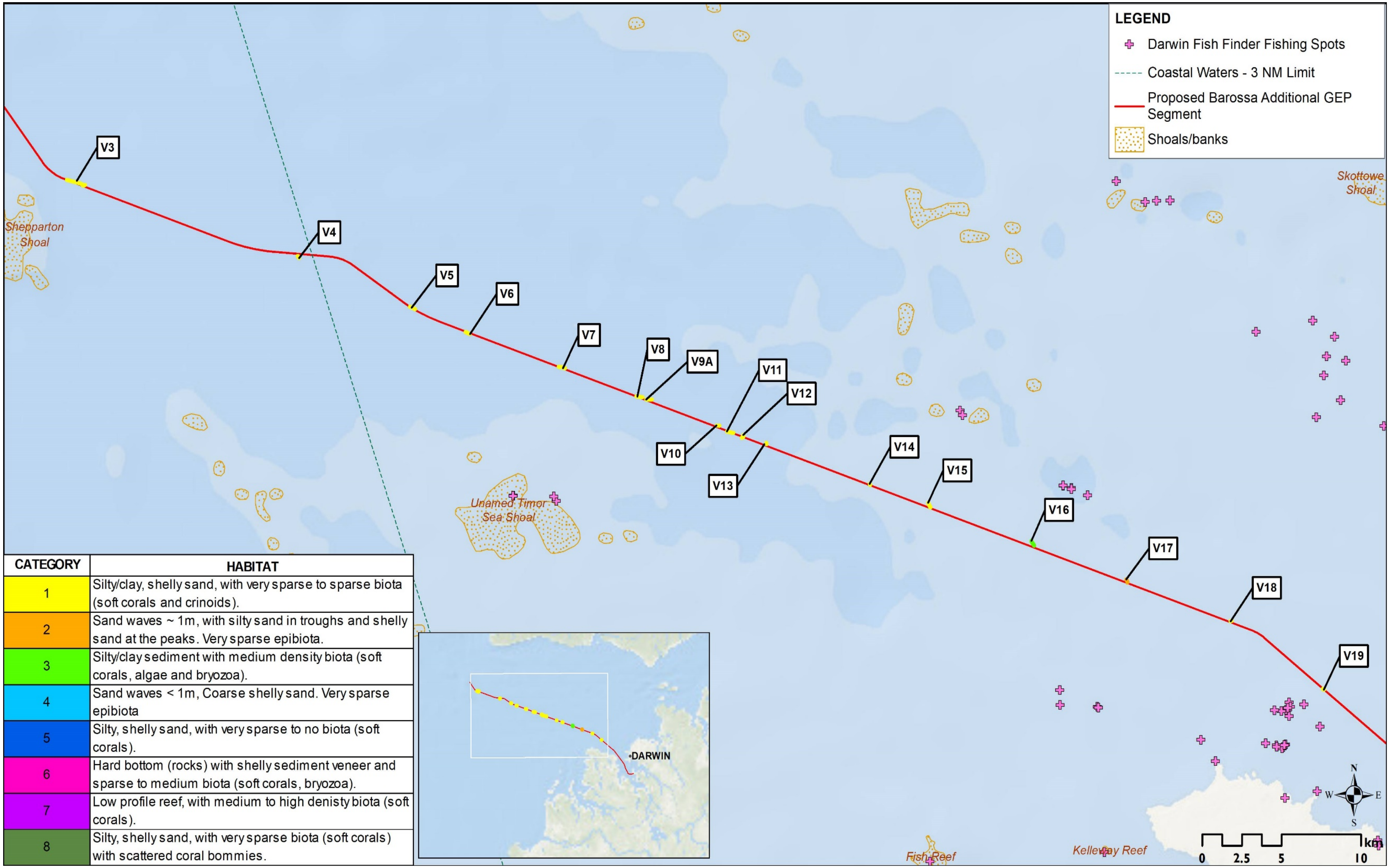
3.1 Benthic Habitat

Eight high-level habitat types were identified along the Barossa DPD pipeline route and in the spoil ground area. This comprised six soft substrate habitats and two hard substrate habitats. The hard substrate habitats were limited to the Darwin Harbour section of the pipeline route. Darwin Fish Finder TM GPS Database was used to overlay fishing sites onto the habitat maps. Offshore fishing sites were commonly identified with known shoals, rather than the pipeline (Figure 3-1 and Figure 3-2). Inside Darwin Harbour, higher densities of fishing sites were located in close proximity to areas identified as hard substrate (Figure 3-4 and Figure 3-5).



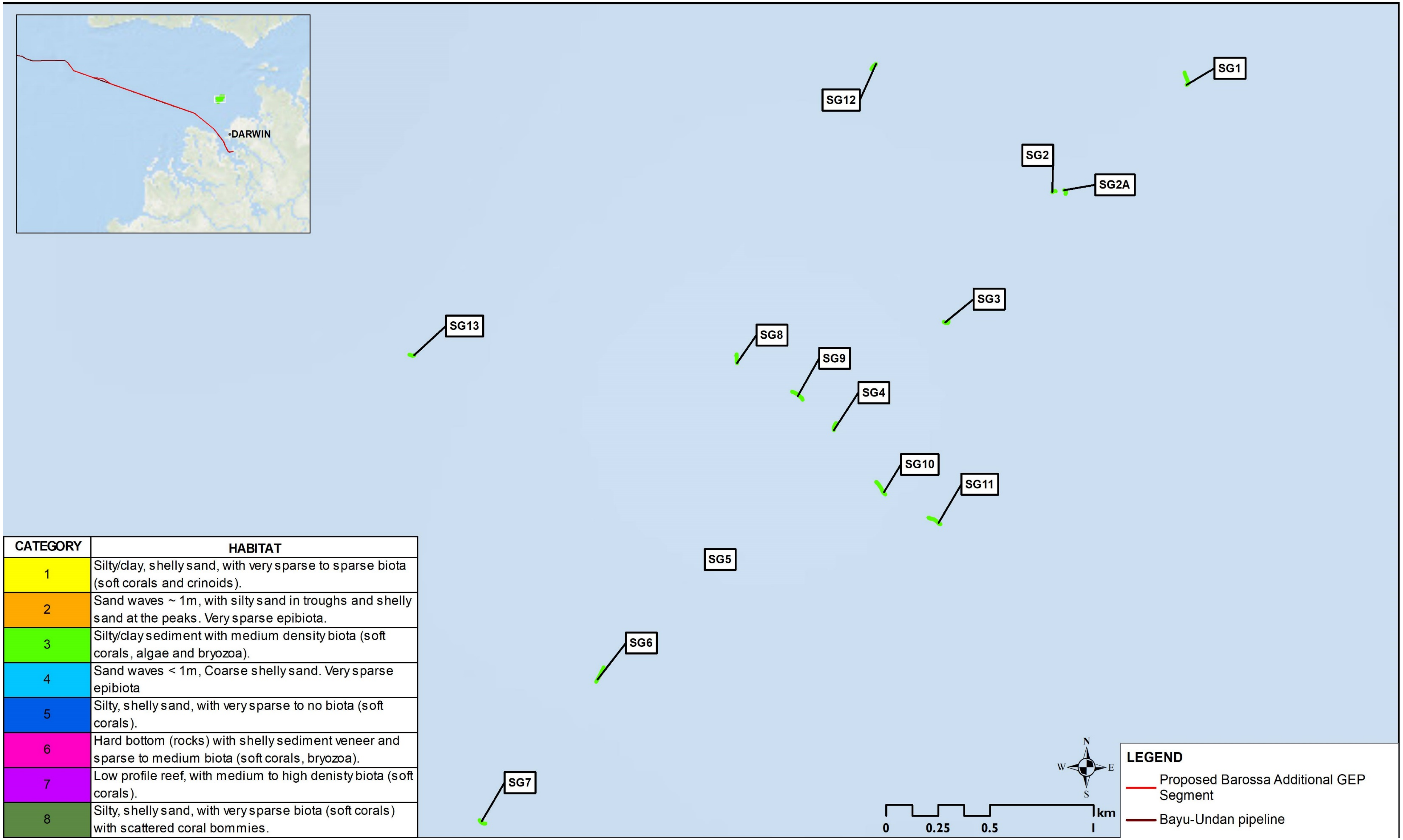
CATEGORY	HABITAT
1	Silty/clay, shelly sand, with very sparse to sparse biota (soft corals and crinoids).
2	Sand waves ~ 1m, with silty sand in troughs and shelly sand at the peaks. Very sparse epibiota.
3	Silty/clay sediment with medium density biota (soft corals, algae and bryozoa).
4	Sand waves < 1m, Coarse shelly sand. Very sparse epibiota
5	Silty, shelly sand, with very sparse to no biota (soft corals).
6	Hard bottom (rocks) with shelly sediment veneer and sparse to medium biota (soft corals, bryozoa).
7	Low profile reef, with medium to high denisty biota (soft corals).
8	Silty, shelly sand, with very sparse biota (soft corals) with scattered coral bommies.

Figure 3-1: Habitat types identified along the offshore pipeline route and Darwin fish finder fishing spots



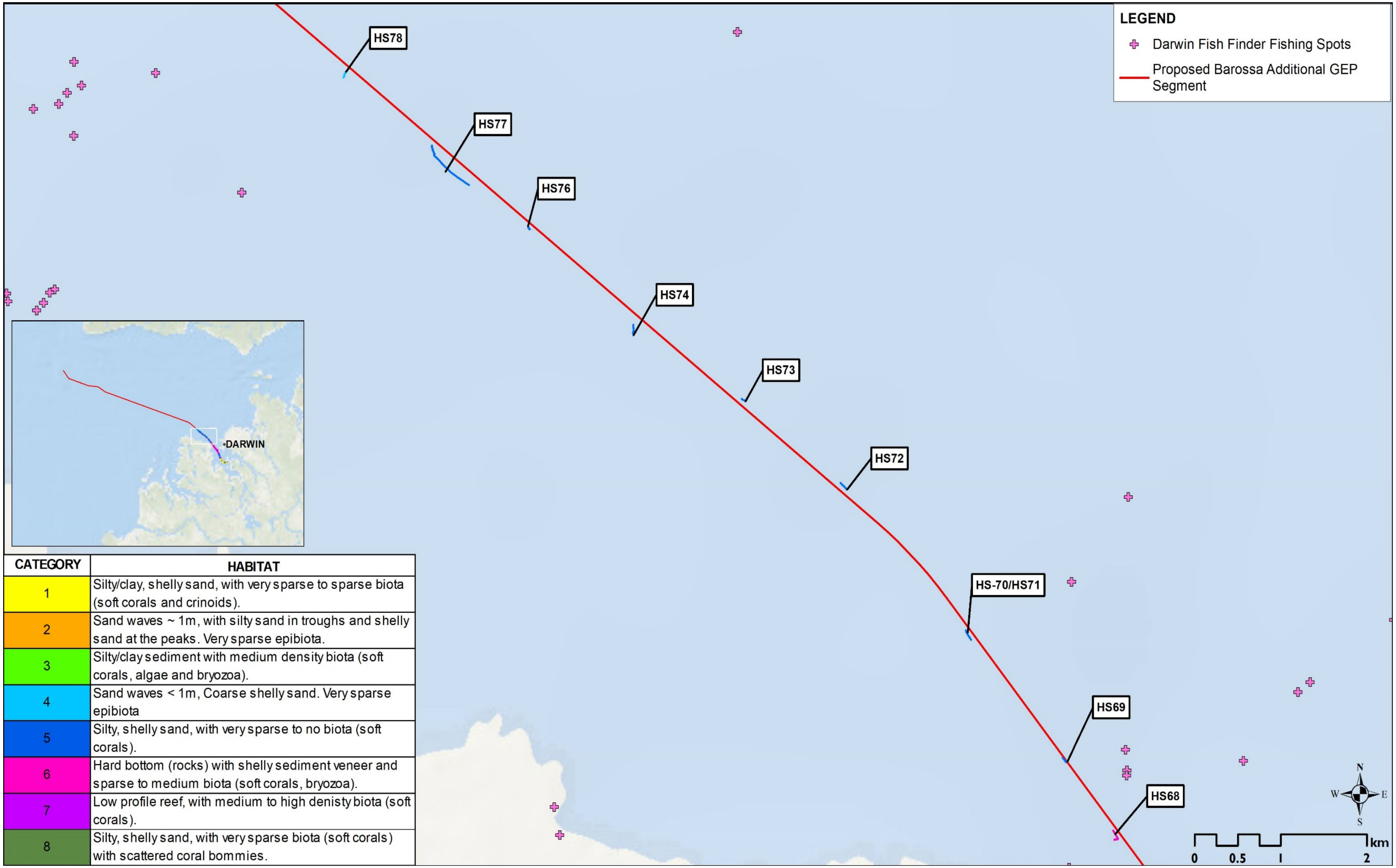
CATEGORY	HABITAT
1	Silty/clay, shelly sand, with very sparse to sparse biota (soft corals and crinoids).
2	Sand waves ~ 1m, with silty sand in troughs and shelly sand at the peaks. Very sparse epibiota.
3	Silty/clay sediment with medium density biota (soft corals, algae and bryozoa).
4	Sand waves < 1m, Coarse shelly sand. Very sparse epibiota
5	Silty, shelly sand, with very sparse to no biota (soft corals).
6	Hard bottom (rocks) with shelly sediment veneer and sparse to medium biota (soft corals, bryozoa).
7	Low profile reef, with medium to high denisty biota (soft corals).
8	Silty, shelly sand, with very sparse biota (soft corals) with scattered coral bommies.

Figure 3-2: Habitat types identified along the offshore pipeline route and Darwin fish finder fishing spots



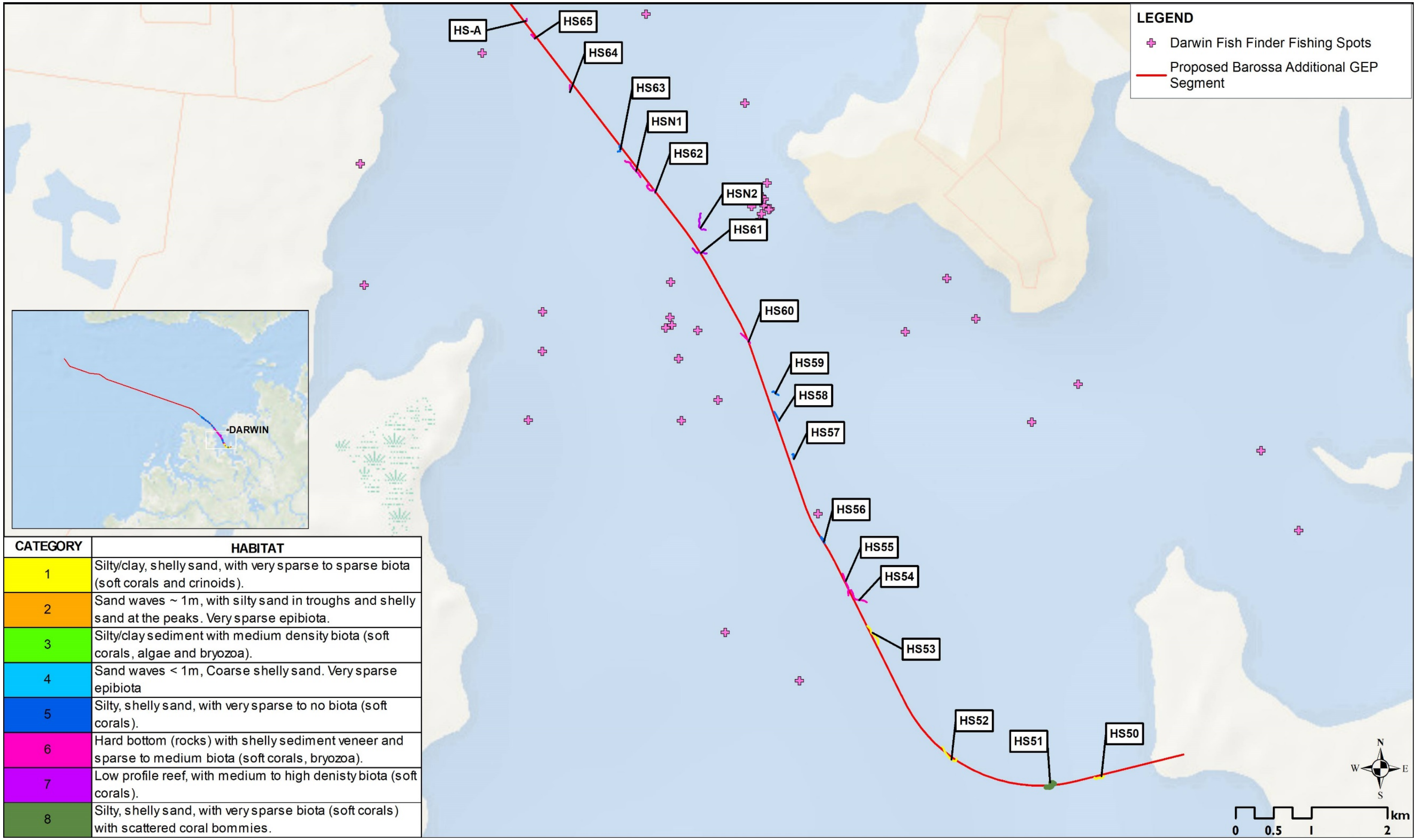
CATEGORY	HABITAT
1	Silty/clay, shelly sand, with very sparse to sparse biota (soft corals and crinoids).
2	Sand waves ~ 1m, with silty sand in troughs and shelly sand at the peaks. Very sparse epibiota.
3	Silty/clay sediment with medium density biota (soft corals, algae and bryozoa).
4	Sand waves < 1m, Coarse shelly sand. Very sparse epibiota
5	Silty, shelly sand, with very sparse to no biota (soft corals).
6	Hard bottom (rocks) with shelly sediment veneer and sparse to medium biota (soft corals, bryozoa).
7	Low profile reef, with medium to high denisty biota (soft corals).
8	Silty, shelly sand, with very sparse biota (soft corals) with scattered coral bommies.

Figure 3-3: Habitat types identified within the Spoil Ground and Darwin fish finder fishing spots



CATEGORY	HABITAT
1	Silty/clay, shelly sand, with very sparse to sparse biota (soft corals and crinoids).
2	Sand waves ~ 1m, with silty sand in troughs and shelly sand at the peaks. Very sparse epibiota.
3	Silty/clay sediment with medium density biota (soft corals, algae and bryozoa).
4	Sand waves < 1m, Coarse shelly sand. Very sparse epibiota
5	Silty, shelly sand, with very sparse to no biota (soft corals).
6	Hard bottom (rocks) with shelly sediment veneer and sparse to medium biota (soft corals, bryozoa).
7	Low profile reef, with medium to high denisty biota (soft corals).
8	Silty, shelly sand, with very sparse biota (soft corals) with scattered coral bommies.

Figure 3-4: Habitat types identified along the northern end of the Darwin Harbour pipeline route and Darwin fish finder fishing spots



CATEGORY	HABITAT
1	Silty/clay, shelly sand, with very sparse to sparse biota (soft corals and crinoids).
2	Sand waves ~ 1m, with silty sand in troughs and shelly sand at the peaks. Very sparse epibiota.
3	Silty/clay sediment with medium density biota (soft corals, algae and bryozoa).
4	Sand waves < 1m, Coarse shelly sand. Very sparse epibiota
5	Silty, shelly sand, with very sparse to no biota (soft corals).
6	Hard bottom (rocks) with shelly sediment veneer and sparse to medium biota (soft corals, bryozoa).
7	Low profile reef, with medium to high denisty biota (soft corals).
8	Silty, shelly sand, with very sparse biota (soft corals) with scattered coral bommies.

Figure 3-5: The habitat along the southern end of the Darwin Harbour pipeline route and Darwin fish finder fishing spots

3.1.1 Soft substrate habitats

3.1.1.1 Offshore pipeline

From KP0 to KP65, seabed habitat was characterised as silty/clay shelly sand (Plate 3-1), with very sparse to sparse conspicuous epibiota (mainly soft corals and crinoids). This soft sediment habitat was identified again at the shoreward end of the pipeline route (near the shore crossing). Biota commonly associated with this habitat type included:

- soft corals, including gorgonians, sea whips (*Junceella* spp.), Neptheidae and Alcyoniidae (Plate 3-2)
- echinoderms including sea urchins, sea stars, sea cucumbers and crinoids (Plate 3-3)
- molluscs, including squid
- crustaceans including shrimp and the painted pebble crab (*Leucosia anatum*).
- burrows and polychaete tubes.

Plate 3-1: Grab sample from site OP1, showing silty shelly sand with clumps of clay.

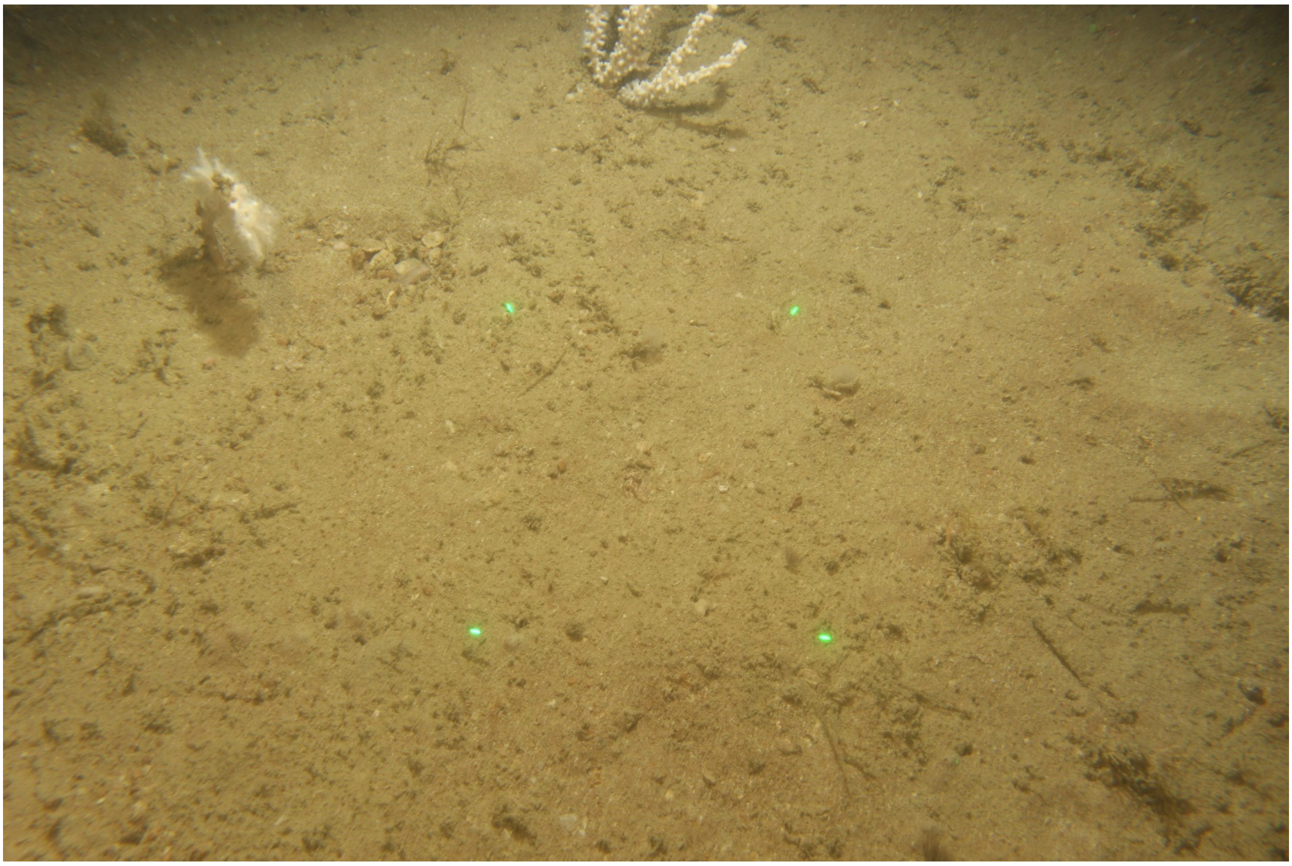


Plate 3-2: Silty, shelly sand with very sparse soft corals (Alcyoniidae) at site OP1

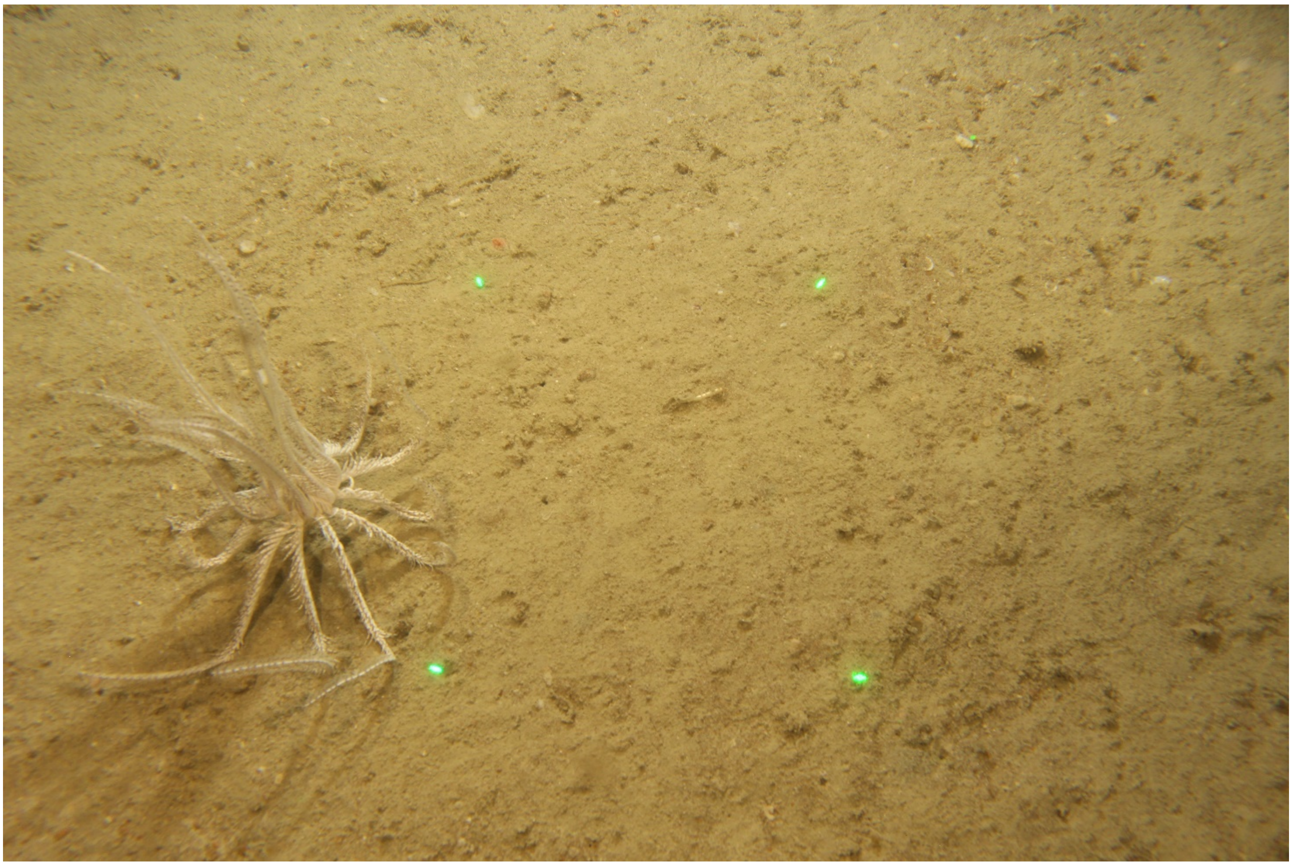


Plate 3-3: Silty/clay sand with a motile crinoid at site V12

Sand waves were recorded at three of these silty/clay shelly sand sites (V10, V11 and V12), roughly 1 m in height, with silty sand in the troughs and coarse shelly sand at the crests. This substrate was associated with very sparse epibiota.

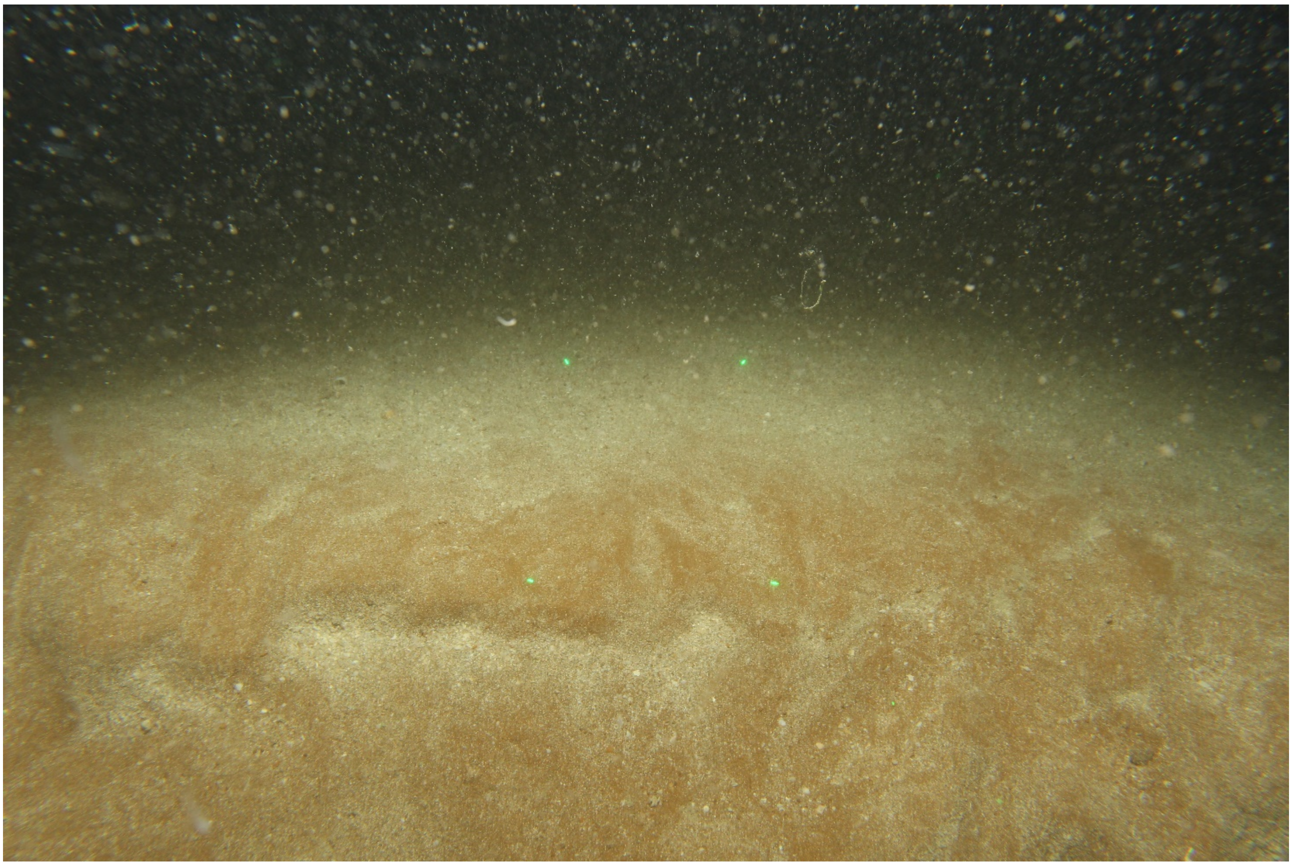


Plate 3-4: A small sand wave at site V11, with coarse, shelly sand at the crest

3.1.1.2 Spoil Ground

The spoil ground sites all consisted of similar soft substrate habitat, which was only identified at one other site along the pipeline (V16). This habitat is defined by silty/clay sediment with medium density biota (soft corals, algae and Bryozoa). Biota commonly associated with this habitat were soft corals (gorgonians, *Junceella* spp. and Alcyoniidae), branching and encrusting sponges, Bryozoa (lace corals), invertebrate burrows, polychaete tubes, brown algae and occasional motile crinoids.

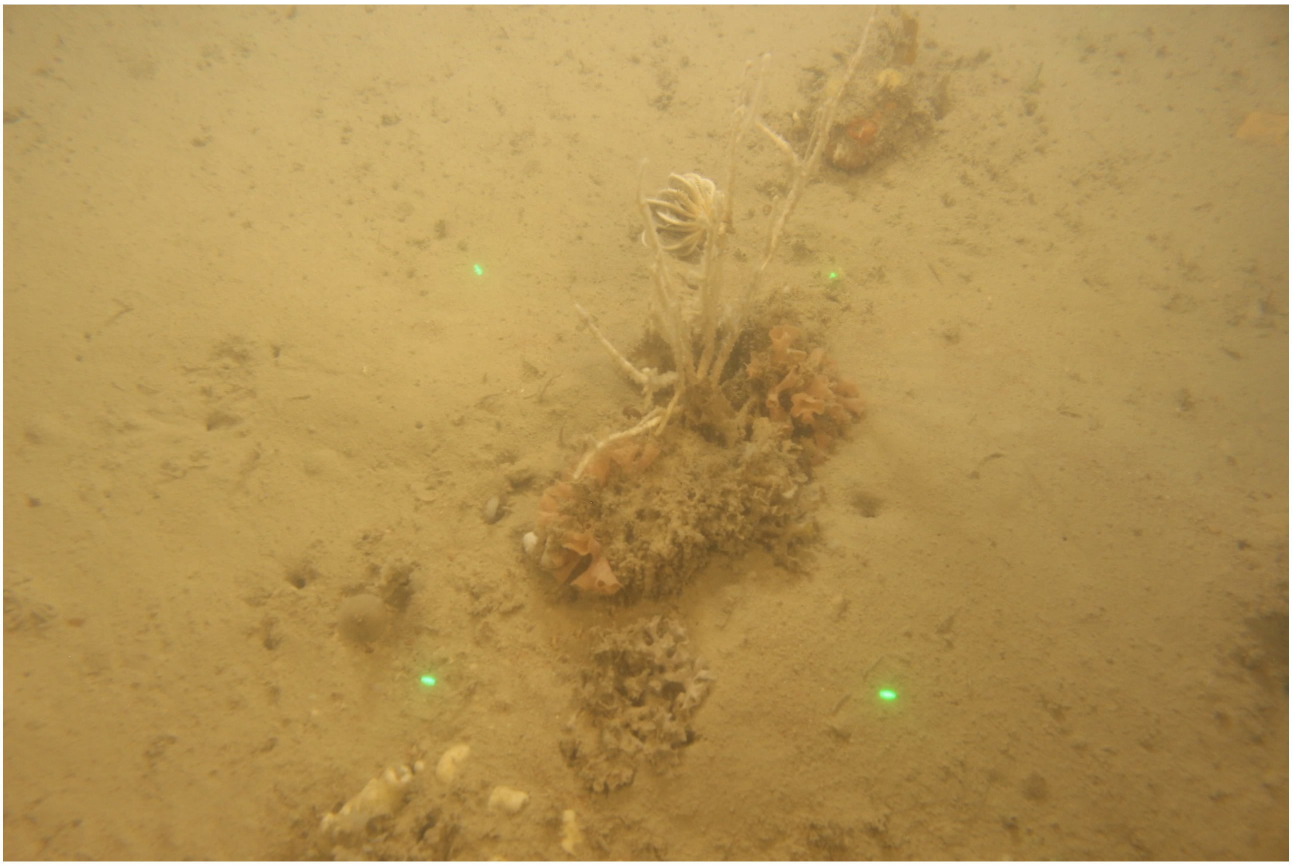


Plate 3-5: Silty/clay sediment with soft corals, Bryozoa (lace coral) and a motile crinoid at site SG10

3.1.1.3 Darwin Harbour

There were three main soft substrate habitat types identified in Darwin Harbour. The first was coarse shelly sand waves, less than 1 m in height with very sparse epibiota (Plate 3-6). This habitat was only recorded at three sites (HS78, HS79 and HS80), all of which were in the potential sand wave dredging zone at the outer edges of Darwin Harbour (Plate 3-7). While this habitat is very sparse in conspicuous epibiota, grab samples from one of the sites in this area (HS33) retrieved a very high density of hermit crabs (Plate 3-8), with over 100 crabs recorded from each grab.

The most common soft substrate habitat type within Darwin harbour consisted of silty, shelly sand, with very sparse soft corals to no conspicuous epibiota (Plate 3-9). The epibiota recorded from this habitat included hydroids, occasional soft corals and sea pens (gorgonians, Pennatulacea, *Junceella* spp. and Alcyoniidae), Bryozoa (lace corals), sea urchins and sea stars.

A mixed habitat of silty shelly sand, with very sparse biota (soft corals) with scattered coral bommies was recorded at only one site, HS51 (Plate 3-10). The coral bommies supported assemblages of hydroids, soft corals (gorgonians), anemone colonies and encrusting sponges.

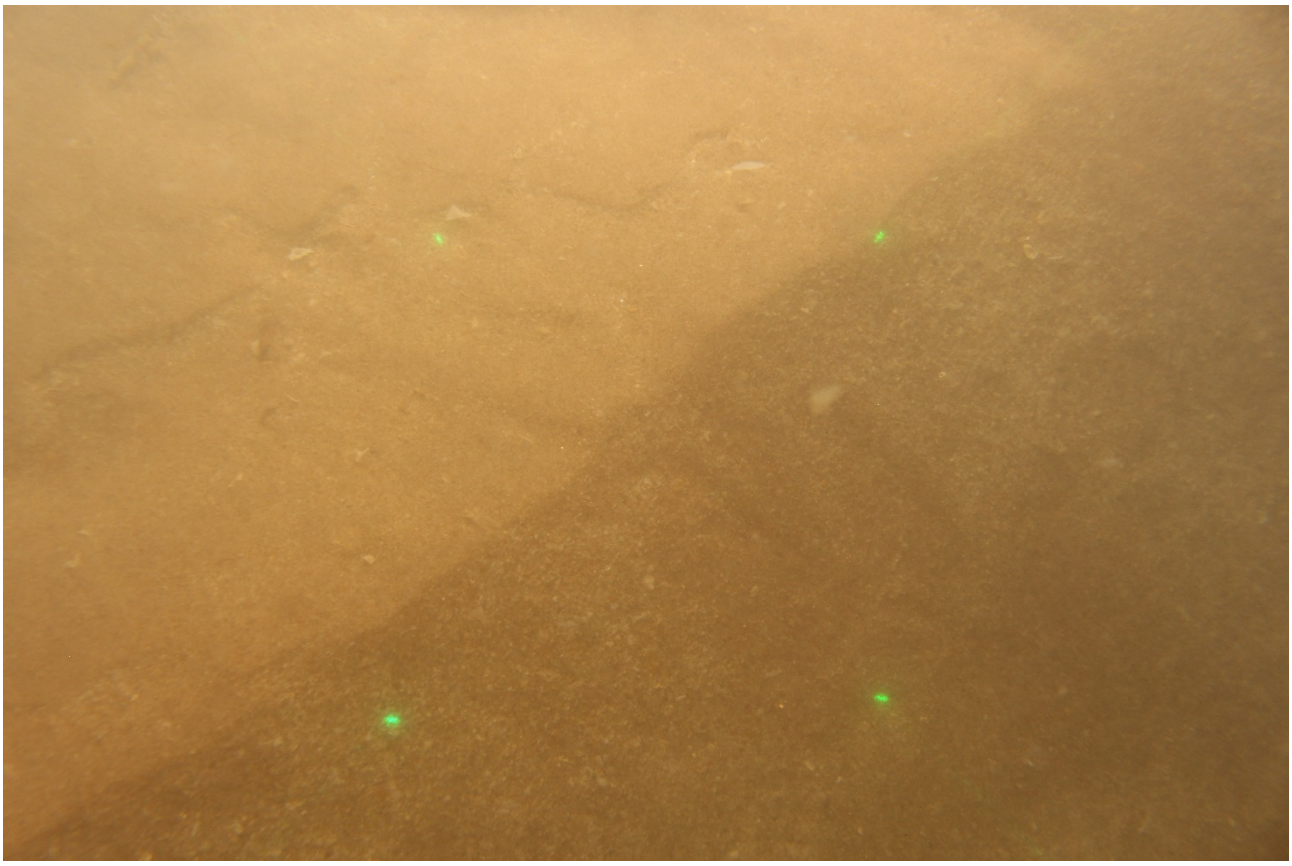


Plate 3-6: Coarse shelly sand waves with very sparse epibiota at site HS78

Plate 3-7: Coarse shelly sand from site HS34, inside the potential sand wave dredging zone at the outer edge of Darwin Harbour

Plate 3-8: Hermit crabs from site HS33

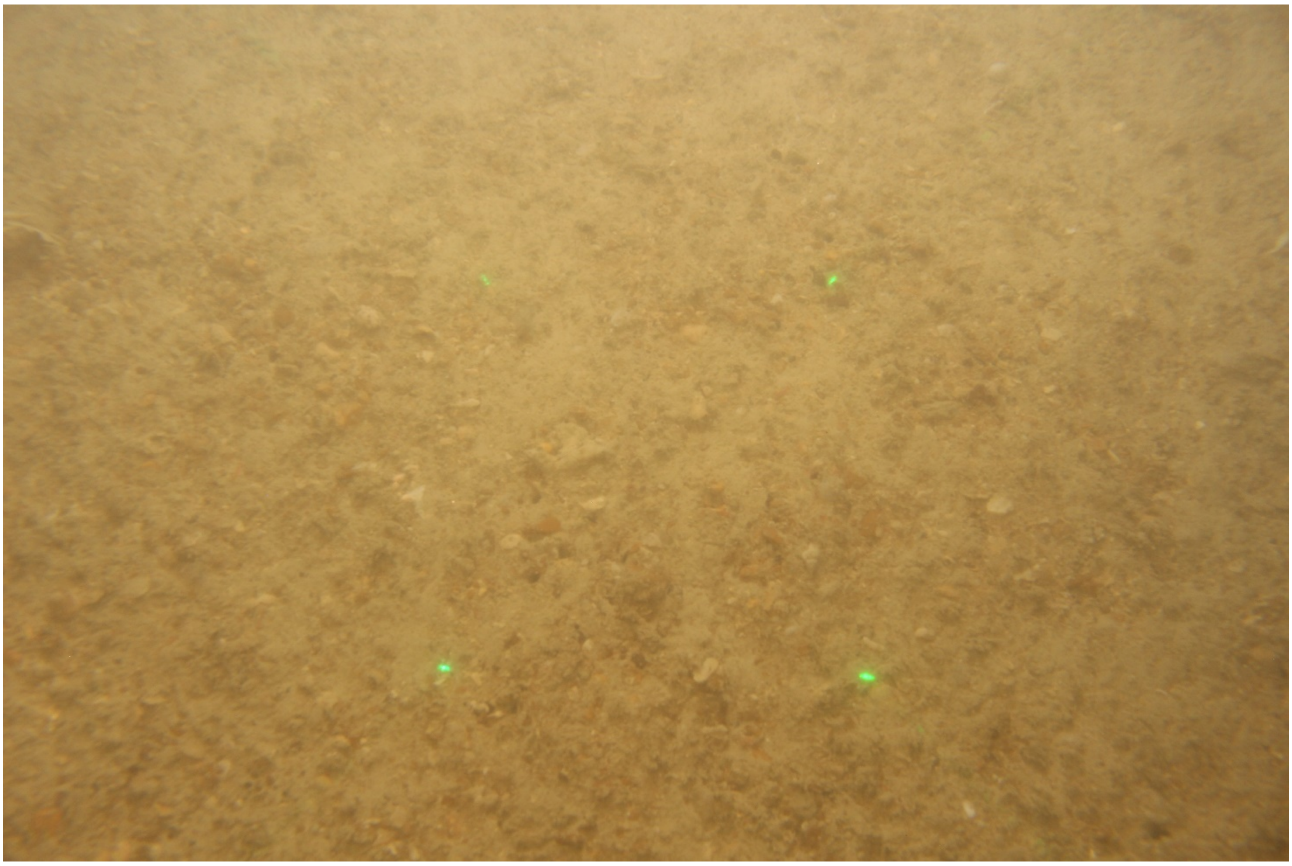


Plate 3-9: Silty shelly sand, with very sparse to no conspicuous epibiota at site HS73

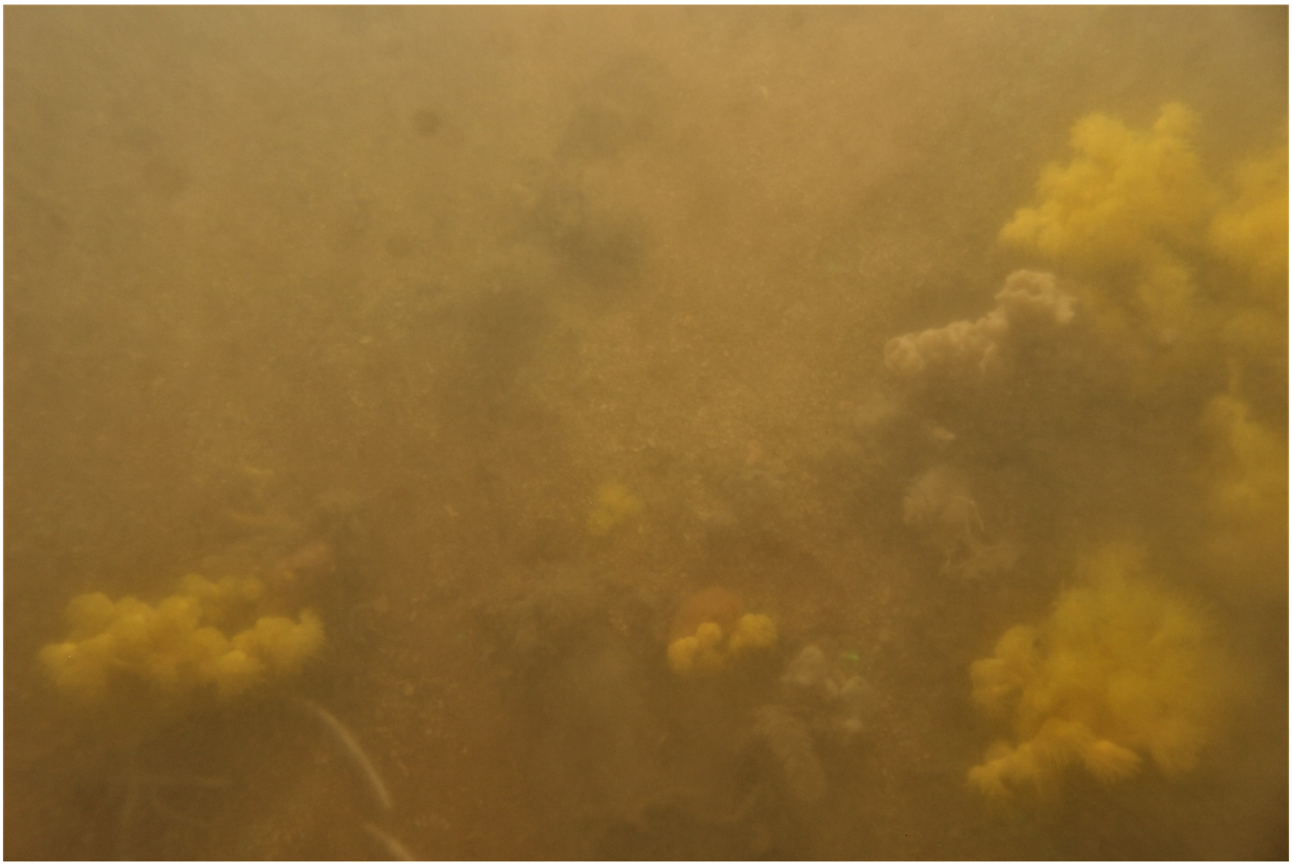


Plate 3-10: Silty shelly sand and part of a coral bommie supporting assemblages of sponges, anemones and soft corals at site HS51

3.1.2 Hard substrate habitats

3.1.2.1 Darwin Harbour

Most of the hard substrates were recorded along the section of the pipeline route offshore from Fanny Bay. Most of these sites were hard bottom (consolidated rocks) with a shelly coarse sediment veneer and sparse to medium conspicuous epibiota (mainly soft corals and bryozoans) (Plate 3-11). However, low profile reef was recorded at sites HS61 and HSN2, with medium to high density epibiota. The epibiota associated with this habitat type included hydroids, soft corals (gorgonians, *Junceella* spp.), brown algae, bryozoans (lace corals), ascidians, and encrusting, digitate and globular sponges.

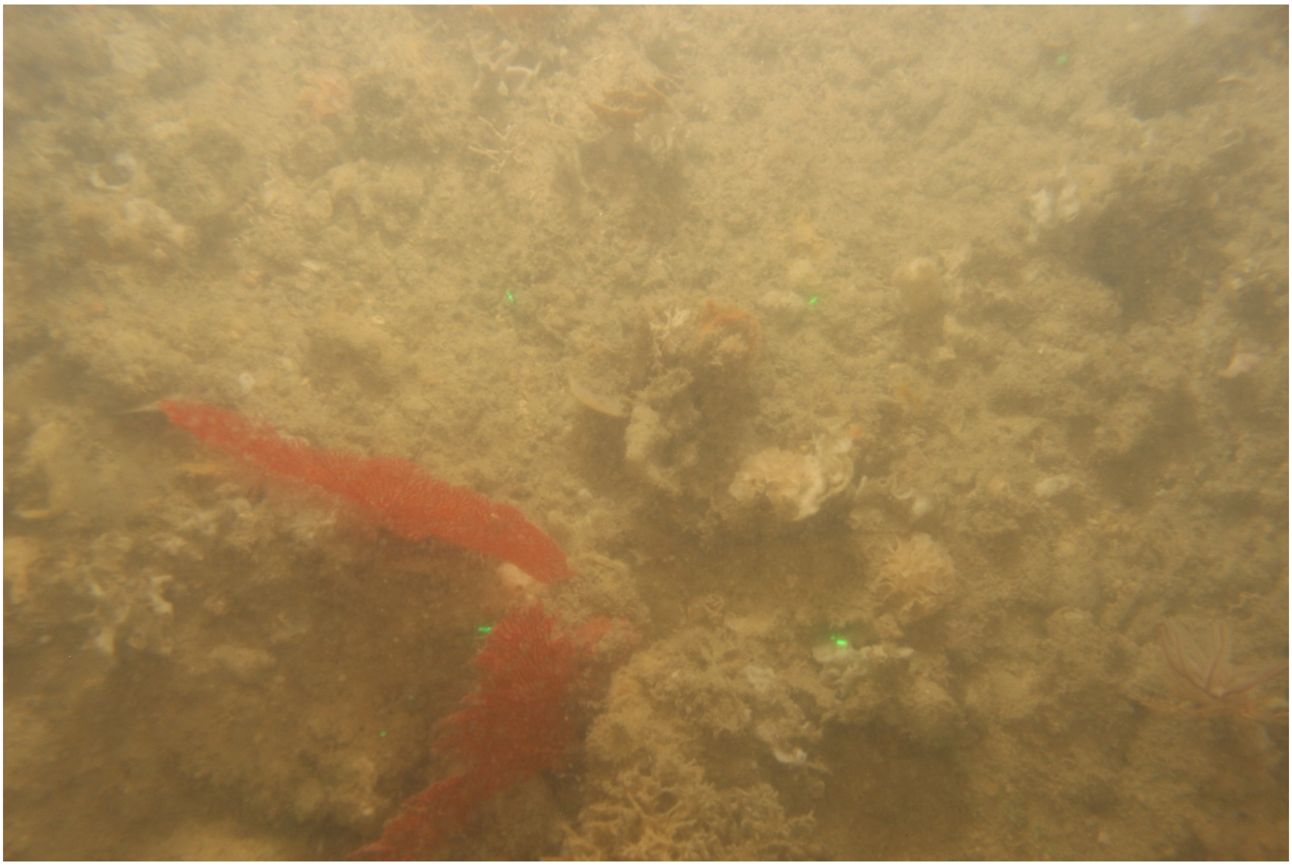


Plate 3-11: Hard bottom (consolidated granite rocks) with a shelly sediment veneer supporting gorgonians and bryozoans (lace corals) at site HS68

Plate 3-12: Low-profile reef with medium density gorgonians and sponges at site HSN2

3.2 Sediment quality

3.2.1 Offshore pipeline

3.2.1.1 Hydrocarbons

The total recoverable hydrocarbons (TRH) and BTEXN concentrations at offshore pipeline sites were below the limit of reporting (LoR) for all samples. Therefore, no polycyclic aromatic hydrocarbon (PAH) analysis was undertaken at these sites.

3.2.2 Darwin Harbour pipeline

3.2.2.1 Hydrocarbons

Total petroleum hydrocarbons (TPH) and total recoverable hydrocarbons (TRH) were detected at 35 of the 53 Darwin Harbour sites, these ranged from <3 to 9 mg/kg (raw data) (Table 3-1). TPH and TRH results were normalised to 1% Total Organic Carbon (TOC). The normalised TPH and TRH concentrations were below the Default Guideline Value (DGV) of 280 mg/kg across all sites (Figure 3-6). Polycyclic aromatic hydrocarbons (PAHs) were requested for these 35 sites. All PAH concentrations were below the LoR.

Table 3-1: Total recoverable hydrocarbons detected above the LOR, normalised to 1 % TOC

Analyte	TOC (%)	C10-C40 (Sum) (mg/kg)	C10-C36 (Sum) (mg/kg)
DGV			280
HS01	0.36	25.00	19.44
HS02	0.34	17.65	14.71
HS03	0.26	30.77	23.08
HS04	0.46	17.39	10.87
HS05	0.55	9.09	7.27
HS06	0.21	42.86	33.33
HS07	0.24	25.00	16.67
HS08	0.24	20.83	12.50
HS09	0.20	60.00	45.00
HS10	0.22	27.27	18.18
HS11	0.22	36.36	27.27
HS13	0.28	14.29	10.71
HS14	0.34	14.71	8.82
HS15	0.31	19.35	16.13
HS16	0.32	12.50	9.38
HS17	0.14	21.43	<3
HS18	0.14	42.86	28.57
Duplicate C	0.22	18.18	<3
HS19	0.19	21.05	<3
HS20	0.20	20.00	<3
HS21	0.26	19.23	15.38
HS22	0.09	55.56	44.44
HS23	0.22	27.27	18.18
HS24	0.14	28.57	<3
HS26	0.19	31.58	21.05
HS31	0.16	25.00	<3
HS70	0.22	22.73	18.18
Duplicate A	0.20	30.00	25.00
HS74	0.18	27.78	16.67
HS75	0.19	42.11	31.58
HS77	0.21	28.57	23.81
HS35	0.13	30.77	<3
HS38	0.15	26.67	20.00
HS42	0.22	22.73	18.18
HS47	0.17	41.18	35.29
HS48	0.35	22.86	17.14
HS49	0.51	19.61	15.69

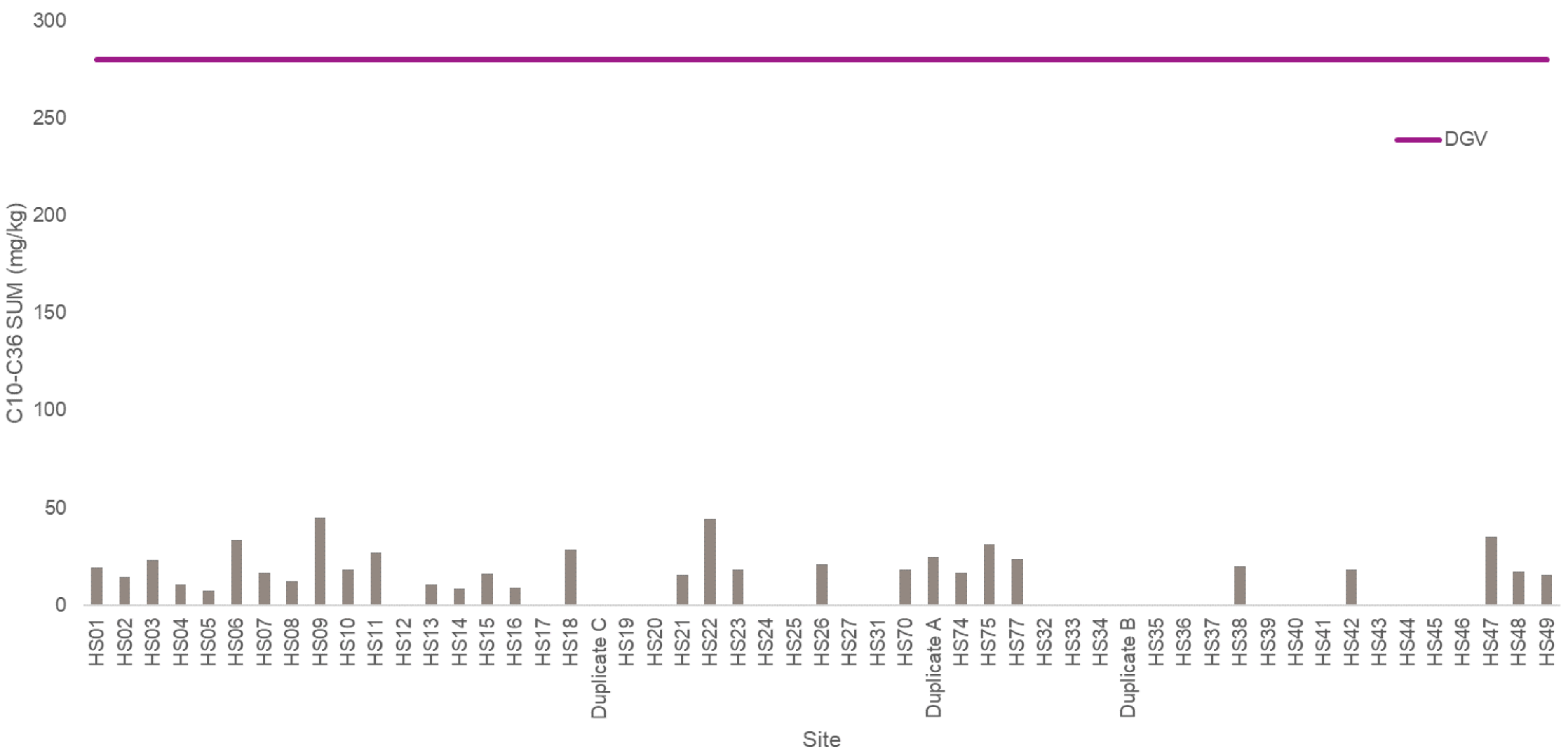


Figure 3-6: Toral recoverable hydrocarbons (normalised to 1% TOC) in Darwin Harbour, from South to North along the pipeline*

*Note duplicate samples were collected from the site directly to the left of the duplicate reference code

3.2.2.2 Metals

The metals and metalloid concentrations for all sites were compared to the Australian & New Zealand Guidelines (ANZG 2018) default guideline values (DGV), where available. Of the metals and metalloids in the sediments sampled from Darwin Harbour; cadmium, mercury and silver were below the LoR for all sites.

Aluminium concentrations were all above the LoR and ranged from 1,330 to 14,600 mg/kg. There is no ANZG (2018) default guideline value (DGV) for aluminium in marine sediments (Figure 3-7). Antimony concentrations were above the LoR at 18 sites, ranging from <0.5 to 1.07 mg/kg (Figure 3-7). All the sites in the potential sand wave dredging area were below the LoR. All samples were below the ANZG (2018) default guideline value (DGV) of 2 mg/kg (Figure 3-7).

Arsenic concentrations were found to be very high inside Darwin Harbour. All samples were above the LoR, and only seven samples were below the ANZG (2018) DGV of 20 mg/kg., all of which were within the potential sand wave dredging area. Arsenic concentrations ranged from 8.27 to 108 mg/kg, with a total of nine samples (HS06, HS07, HS08, HS09, HS10, HS11, HS12, HS20 and HS24) above the ANZG (2018) high guideline value (GV-High) of 70 mg/kg (Figure 3-7).

Chromium concentrations were above the LoR at all sites and ranged from 6.9 to 114 mg/kg. Only one sample (HS31) was above the ANZG (2018) DGV of 80 mg/kg (Figure 3-7).

Cobalt concentrations were above the LoR at all sites, ranging from 1 to 10.9 mg/kg. There is no ANZG (2018) DGV for cobalt in marine sediments. Cobalt concentrations were generally high at the southern end of the pipeline, with lower concentrations found within the potential sand wave dredging area (Figure 3-7).

Eleven sites had copper concentrations below the LoR. These sites were all within the potential sand wave dredging area. Copper concentrations within Darwin Harbour ranged from <1 to 7.6 mg/kg. All sites were well below the ANZG (2018) DGV of 65 mg/kg (Figure 3-7).

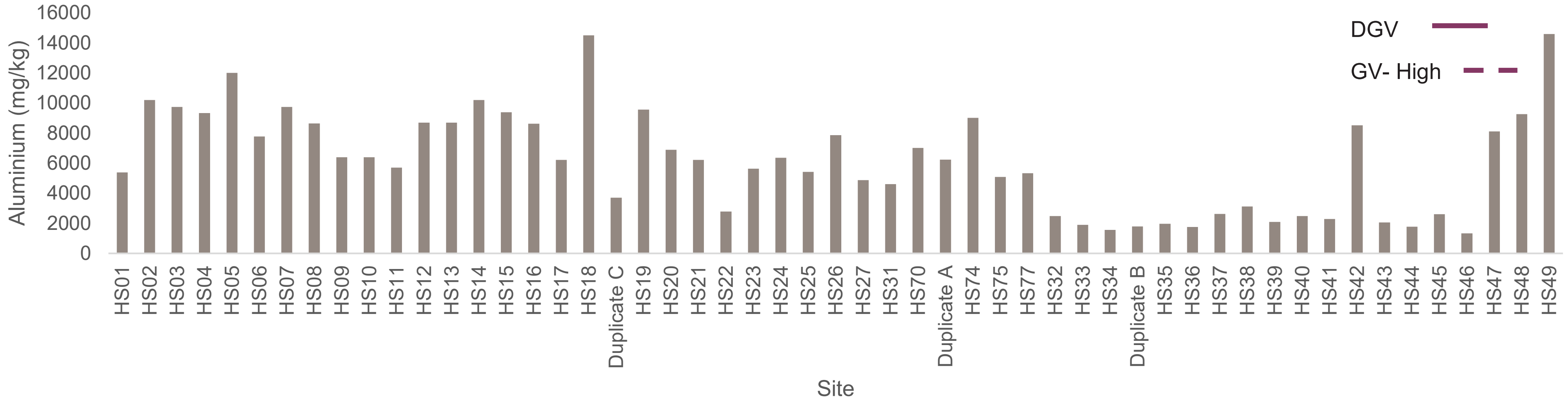
Iron concentrations were all above the LoR at all sites and ranged from 8,140 to 58,100 mg/kg. There is no ANZG (2018) DGV for iron in marine sediments. Iron concentrations were lowest within the potential sand wave dredge area (Figure 3-7).

Lead concentrations were all above the LoR and ranged from 1.6 to 28 mg/kg. All sites were below the ANZG (2018) DGV of 50 mg/kg. Lead concentrations were slightly lower within the sand wave dredge area (Figure 3-7).

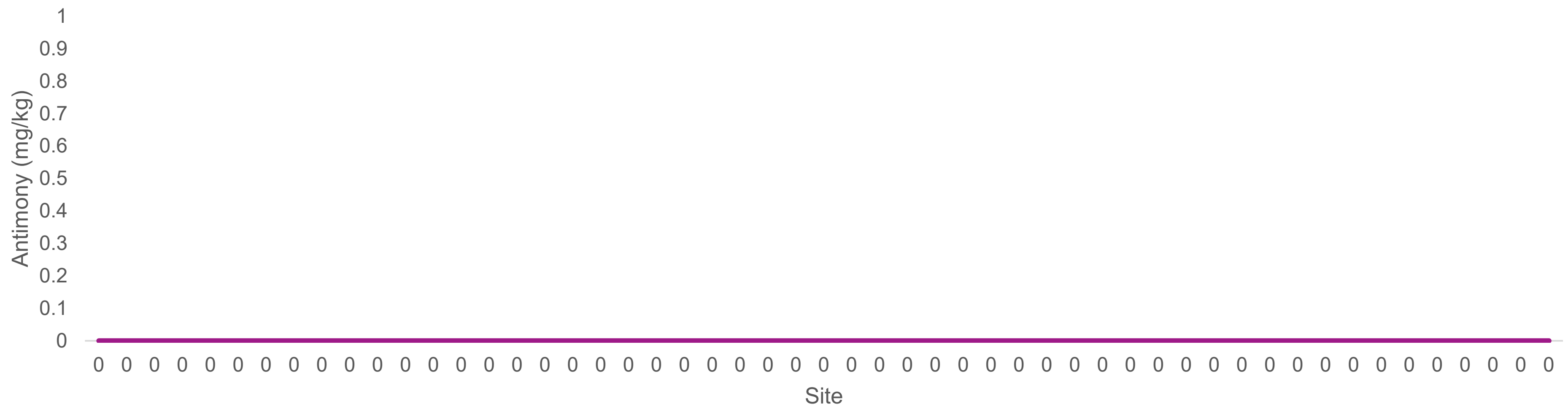
Manganese concentrations were variable across Darwin Harbour but were generally high within the proposed sand wave dredging area. Manganese concentrations were all above the LoR and ranged from 169 to 800 mg/kg (Figure 3-7). There is no ANZG (2018) DGV for manganese in marine sediments.

Nickel concentrations were all above the LoR at all sites and ranged from 1.6 to 9.8 mg/kg. All sites were below the ANZG (2018) DGV of 21 mg/kg (Figure 3-7).

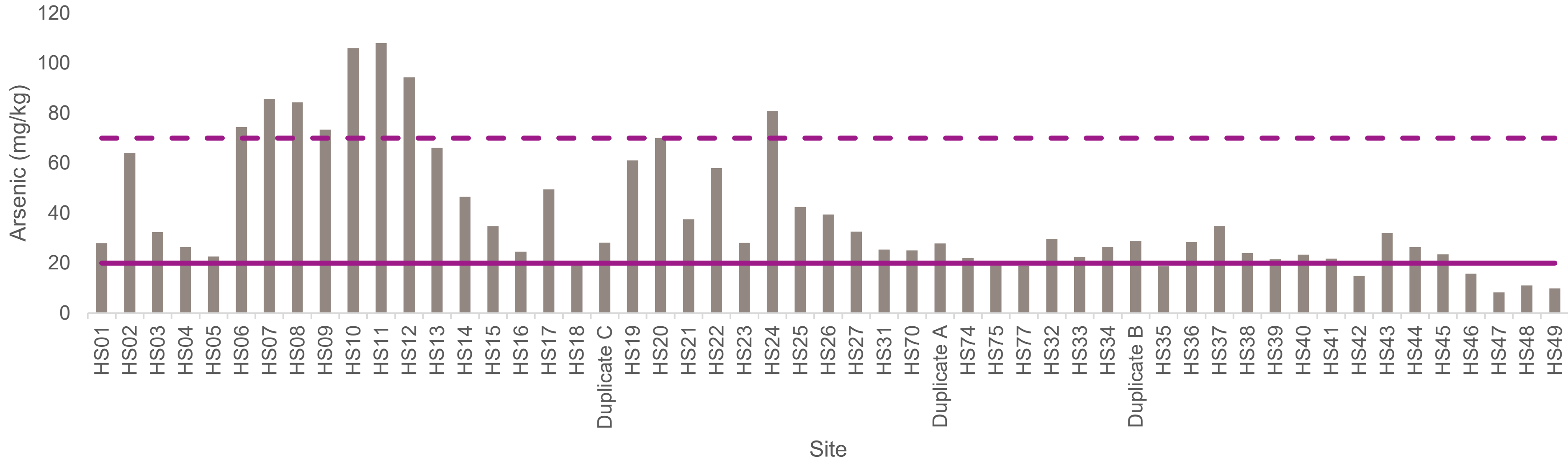
Zinc concentrations were all above the LoR at all sites and ranged from 2 to 20.3 mg/kg. All sites were all below the ANZG (2018) DGV of 200 mg/kg (Figure 3-7).



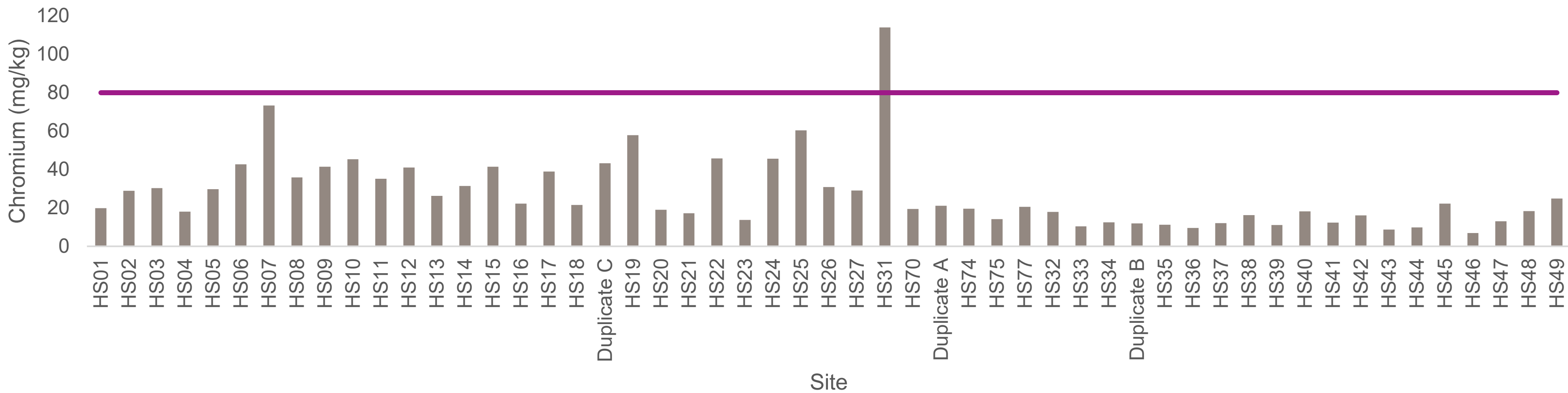
16000
14000
12000
10000
8000
6000
4000
2000
0
Aluminium (mg/kg)
DGV
GV- High
HS01
HS02
HS03
HS04
HS05
HS06
HS07
HS08
HS09
HS10
HS11
HS12
HS13
HS14
HS15
HS16
HS17
HS18
Duplicate C
HS19
HS20
HS21
HS22
HS23
HS24
HS25
HS26
HS27
HS31
HS70
Duplicate A
HS74
HS75
HS77
HS32
HS33
HS34
Duplicate B
HS35
HS36
HS37
HS38
HS39
HS40
HS41
HS42
HS43
HS44
HS45
HS46
HS47
HS48
HS49
Site



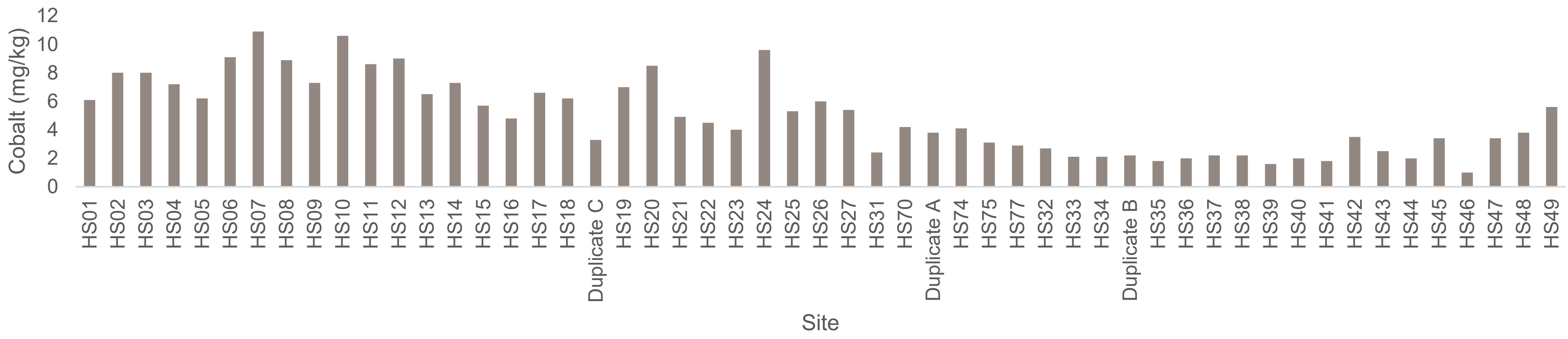
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Antimony (mg/kg)
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
Site



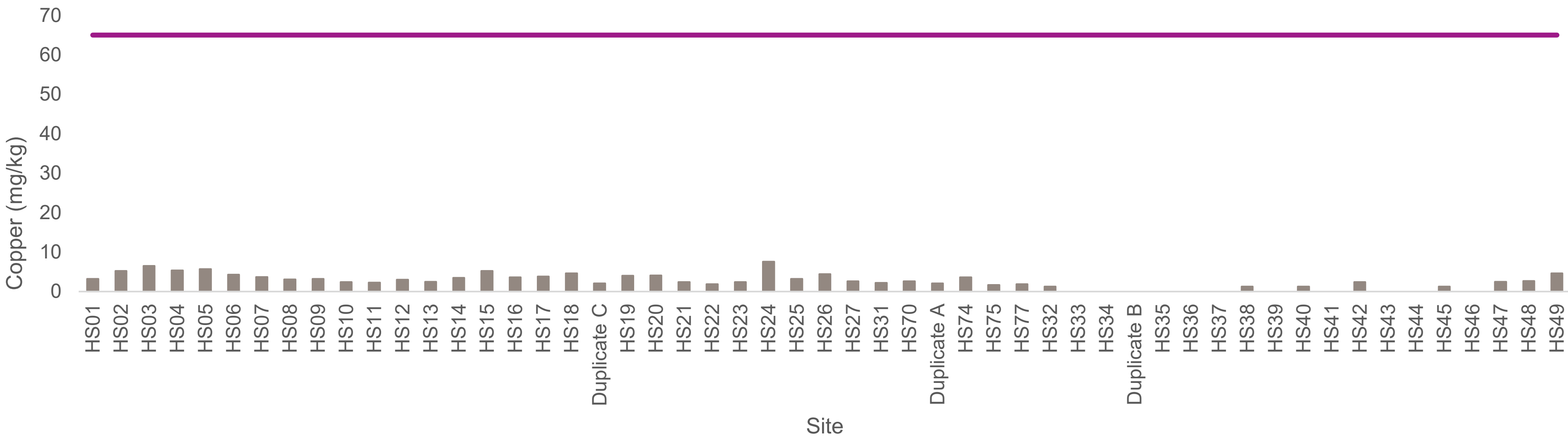
Arsenic (mg/kg)
120
100
80
60
40
20
0
HS01
HS02
HS03
HS04
HS05
HS06
HS07
HS08
HS09
HS10
HS11
HS12
HS13
HS14
HS15
HS16
HS17
HS18
Duplicate C
HS19
HS20
HS21
HS22
HS23
HS24
HS25
HS26
HS27
HS31
HS70
Duplicate A
HS74
HS75
HS77
HS32
HS33
HS34
Duplicate B
HS35
HS36
HS37
HS38
HS39
HS40
HS41
HS42
HS43
HS44
HS45
HS46
HS47
HS48
HS49
Site



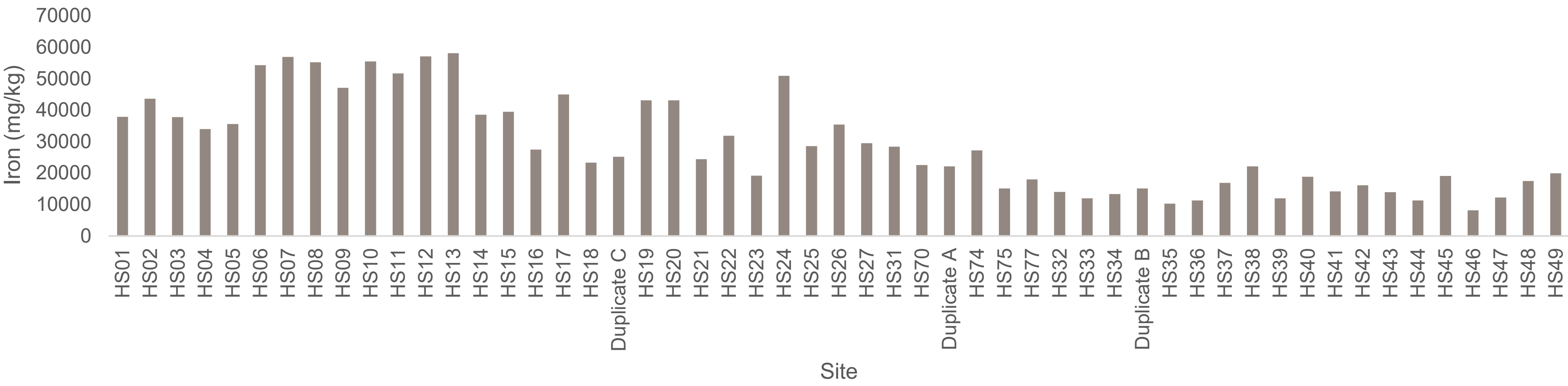
Chromium (mg/kg)
120
100
80
60
40
20
0
HS01
HS02
HS03
HS04
HS05
HS06
HS07
HS08
HS09
HS10
HS11
HS12
HS13
HS14
HS15
HS16
HS17
HS18
Duplicate C
HS19
HS20
HS21
HS22
HS23
HS24
HS25
HS26
HS27
HS31
HS70
Duplicate A
HS74
HS75
HS77
HS32
HS33
HS34
Duplicate B
HS35
HS36
HS37
HS38
HS39
HS40
HS41
HS42
HS43
HS44
HS45
HS46
HS47
HS48
HS49
Site

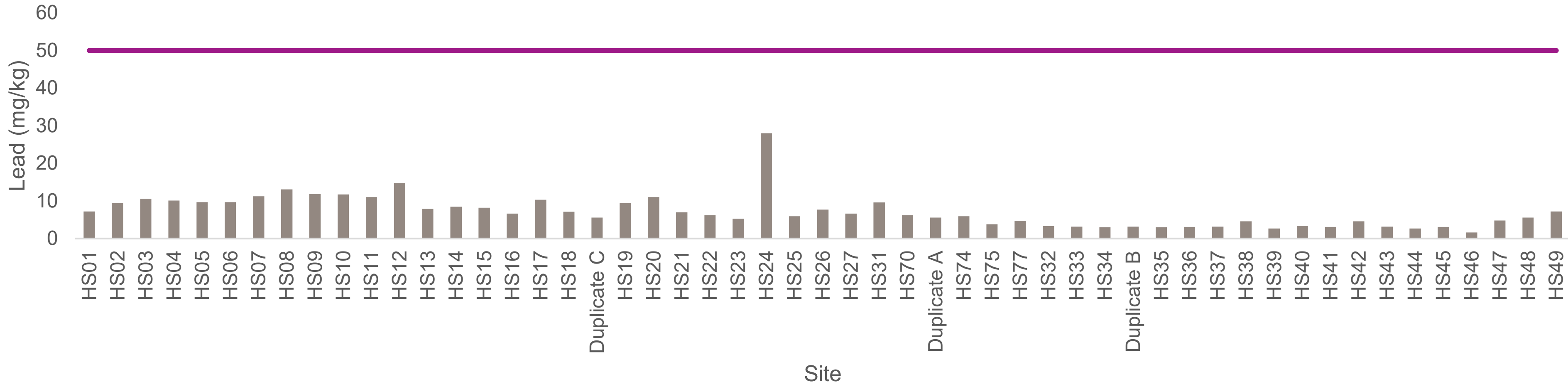


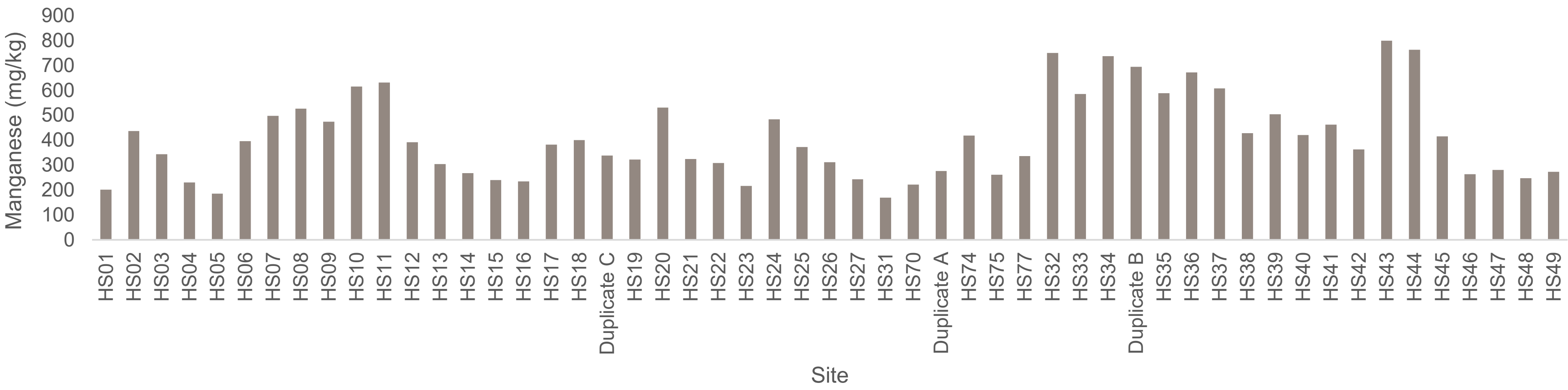
Cobalt (mg/kg)
12
10
8
6
4
2
0
HS01
HS02
HS03
HS04
HS05
HS06
HS07
HS08
HS09
HS10
HS11
HS12
HS13
HS14
HS15
HS16
HS17
HS18
Duplicate C
HS19
HS20
HS21
HS22
HS23
HS24
HS25
HS26
HS27
HS31
HS70
Duplicate A
HS74
HS75
HS77
HS32
HS33
HS34
Duplicate B
HS35
HS36
HS37
HS38
HS39
HS40
HS41
HS42
HS43
HS44
HS45
HS46
HS47
HS48
HS49
Site

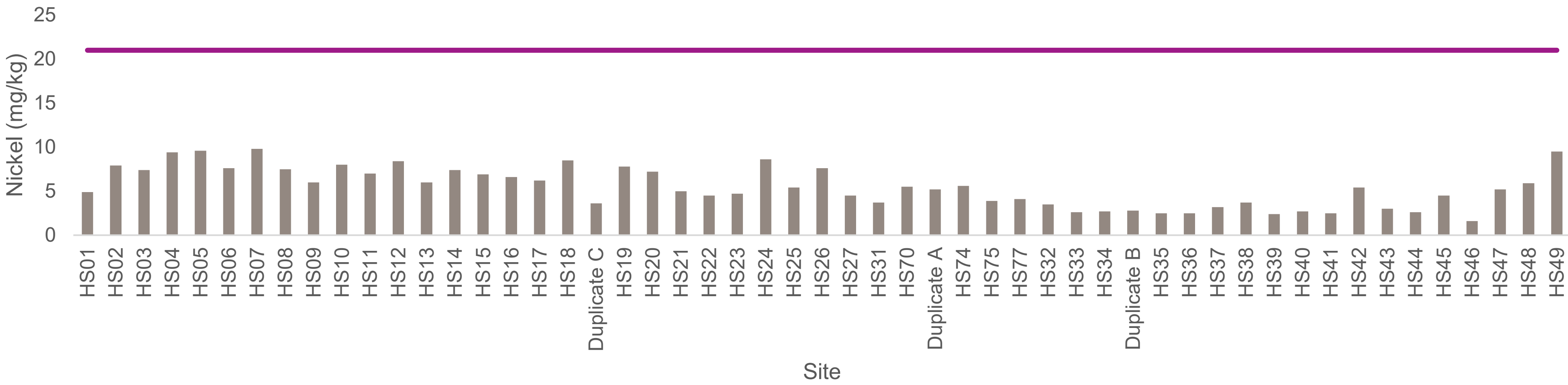


Copper (mg/kg)
70
60
50
40
30
20
10
0
HS01
HS02
HS03
HS04
HS05
HS06
HS07
HS08
HS09
HS10
HS11
HS12
HS13
HS14
HS15
HS16
HS17
HS18
Duplicate C
HS19
HS20
HS21
HS22
HS23
HS24
HS25
HS26
HS27
HS31
HS70
Duplicate A
HS74
HS75
HS77
HS32
HS33
HS34
Duplicate B
HS35
HS36
HS37
HS38
HS39
HS40
HS41
HS42
HS43
HS44
HS45
HS46
HS47
HS48
HS49
Site


Iron (mg/kg)
70000
60000
50000
40000
30000
20000
10000
0
HS01 HS02 HS03 HS04 HS05 HS06 HS07 HS08 HS09 HS10 HS11 HS12 HS13 HS14 HS15 HS16 HS17 HS18 Duplicate C HS19 HS20 HS21 HS22 HS23 HS24 HS25 HS26 HS27 HS31 HS70 Duplicate A HS74 HS75 HS77 HS32 HS33 HS34 Duplicate B HS35 HS36 HS37 HS38 HS39 HS40 HS41 HS42 HS43 HS44 HS45 HS46 HS47 HS48 HS49
Site


Lead (mg/kg)
60
50
40
30
20
10
0
HS01 HS02 HS03 HS04 HS05 HS06 HS07 HS08 HS09 HS10 HS11 HS12 HS13 HS14 HS15 HS16 HS17 HS18 Duplicate C HS19 HS20 HS21 HS22 HS23 HS24 HS25 HS26 HS27 HS31 HS70 Duplicate A HS74 HS75 HS77 HS32 HS33 HS34 Duplicate B HS35 HS36 HS37 HS38 HS39 HS40 HS41 HS42 HS43 HS44 HS45 HS46 HS47 HS48 HS49
Site


Manganese (mg/kg)
900
800
700
600
500
400
300
200
100
0
HS01 HS02 HS03 HS04 HS05 HS06 HS07 HS08 HS09 HS10 HS11 HS12 HS13 HS14 HS15 HS16 HS17 HS18 Duplicate C HS19 HS20 HS21 HS22 HS23 HS24 HS25 HS26 HS27 HS31 HS70 Duplicate A HS74 HS75 HS77 HS32 HS33 HS34 Duplicate B HS35 HS36 HS37 HS38 HS39 HS40 HS41 HS42 HS43 HS44 HS45 HS46 HS47 HS48 HS49
Site


Nickel (mg/kg)
25
20
15
10
5
0
HS01 HS02 HS03 HS04 HS05 HS06 HS07 HS08 HS09 HS10 HS11 HS12 HS13 HS14 HS15 HS16 HS17 HS18 Duplicate C HS19 HS20 HS21 HS22 HS23 HS24 HS25 HS26 HS27 HS31 HS70 Duplicate A HS74 HS75 HS77 HS32 HS33 HS34 Duplicate B HS35 HS36 HS37 HS38 HS39 HS40 HS41 HS42 HS43 HS44 HS45 HS46 HS47 HS48 HS49
Site

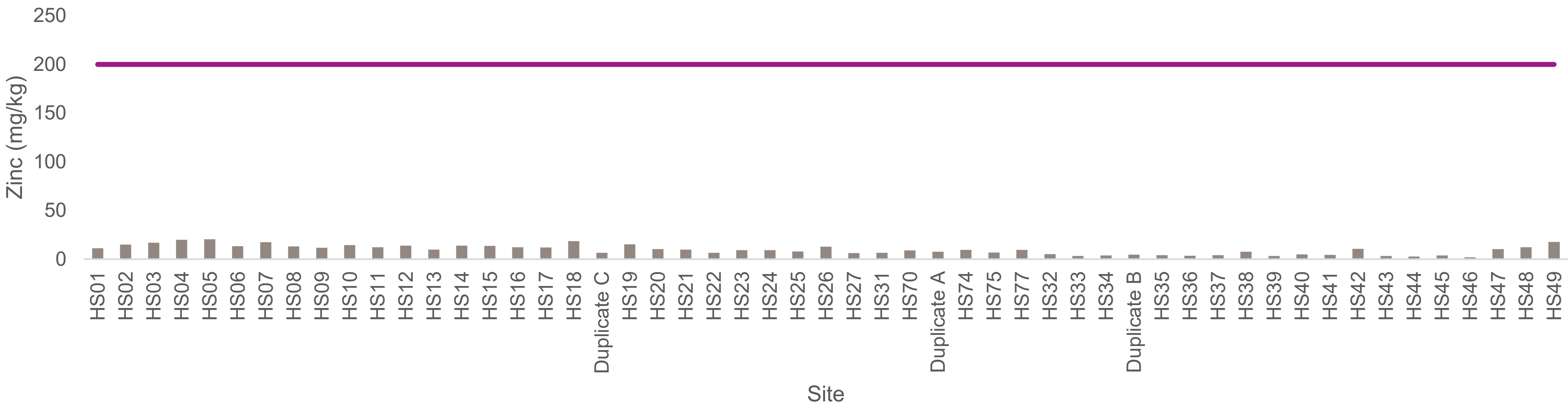


Figure 3-7: Metal concentrations along the Darwin Harbour section of the pipeline route (from South to North)

Arsenic is considered to become concentrated in sedimentary rocks through sedimentation processes. Studies have shown that iron formations and iron rich sediments can contain very large concentrations of natural arsenic (Tanaka, 1988). Arsenic concentrations were therefore plotted against iron concentrations in Darwin Harbour to determine if there was a correlation between arsenic and iron. A strong positive polynomial correlation between iron concentrations and arsenic concentrations was identified (R^2 value of 0.76) (Figure 3-8). This indicated that the higher arsenic concentrations in Darwin Harbour were likely natural (relating to geological sources), rather than anthropogenic in origin.

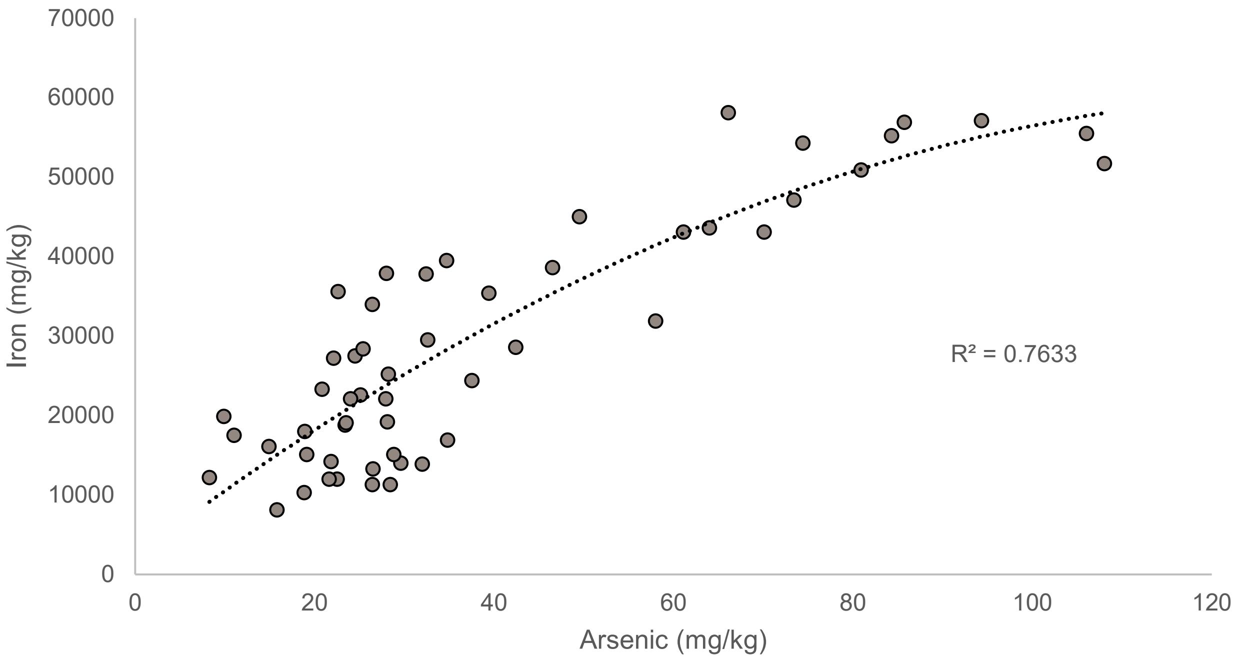


Figure 3-8: The correlation between iron and arsenic concentrations inside Darwin Harbour

3.2.2.3 Nutrients

Total Kjeldahl nitrogen (TKN) concentrations exhibited high concentrations and variability across sites. TKN in Darwin Harbour ranged from 20 to 540 mg/kg. Total phosphorus (TP) concentrations also exhibited high concentrations and variability across sites, ranging from 86 to 1,130 mg/kg. TKN and TP concentrations were generally lower within the proposed sand wave dredging area.

Table 3-2: Total Kjeldahl nitrogen and Total Phosphorus concentrations in Darwin Harbour

Site	Total Kjeldahl Nitrogen as N (mg/kg)	Total Phosphorus as P (mg/kg)
HS01	280	549
HS02	350	428
HS03	380	540
HS04	370	297
HS05	540	416
HS06	180	1120
HS07	300	635
HS08	330	834
HS09	300	589
HS10	330	631
HS11	270	697
HS12	290	1130

HS13	360	661
HS14	310	555
HS15	270	322
HS16	270	485
HS17	280	483
HS18	480	696
Duplicate C	270	319
HS19	260	626
HS20	130	569
HS21	250	422
HS22	220	704
HS23	220	482
HS24	120	758
HS25	150	499
HS26	240	394
HS27	190	152
HS31	160	86
HS70	180	244
Duplicate A	220	398
HS74	380	508
HS75	240	553
HS77	410	270
HS32	80	331
HS33	110	344
HS34	90	408
Duplicate B	60	371
HS35	180	317
HS36	60	338
HS37	20	219
HS38	160	281
HS39	50	250
HS40	100	308
HS41	230	197
HS42	180	403
HS43	40	291
HS44	40	256
HS45	40	212
HS46	30	200
HS47	270	353
HS48	300	310
HS49	470	341

3.2.2.4 Pesticides

Pesticide analysis was undertaken for 33 out of the 53 Darwin Harbour sediment samples. All pesticide chemicals analysed were below the LoR across all sites.

3.2.3 Spoil ground

3.2.3.1 Hydrocarbons

The offshore pipeline total recoverable hydrocarbons (TRH) and BTEXN concentrations were below the limit of reporting (LoR) for all samples. The offshore pipeline samples were, therefore, not tested for polycyclic aromatic hydrocarbons (PAHs).

3.3 Water quality

3.3.1 Offshore pipeline

3.3.1.1 Hydrocarbons

The offshore pipeline total recoverable hydrocarbon (TRH) and BTEXN concentrations were below the limit of reporting (LoR) for all samples (Appendix B). The offshore pipeline samples were, therefore, not tested for polycyclic aromatic hydrocarbons (PAHs).

3.3.1.2 Metals

Five of the filtered and unfiltered metals and metalloids were below the LoR for all sites, except OP1S. These were cadmium (Cd), chromium (Cr), cobalt (Co), nickel (Ni) and mercury (Hg). OPS1 had filtered nickel and unfiltered chromium concentrations that were above the LoR (1.5 µg/L and 0.3 µg/L, respectively).

Filtered and unfiltered copper (Cu) concentrations ranged from <0.2 to 8.4 µg/L (Figure 3-9). Three of the copper samples were above the ANZG (2018) DGV of 1.3 µg/L, in slightly to moderately disturbed marine offshore ecosystems, at the 95% species protection level (Figure 3-9). These results were for unfiltered copper at OP1S and Triplicate B (taken from sample OP8S), and for filtered metals at OP2S. The highest filtered copper concentration was recorded at OP2S (8.4 µg/L), while all other samples had copper concentrations under 1.6 µg/L.

Unfiltered zinc (Zn) concentrations ranged from <1 to 9 µg/L and were at or above the ANZG (2018) DGV of 8 µg/L at two sites (OP1S and OP5S). Filtered zinc concentrations ranged from 1 to 9 µg/L, with three samples being at or above the DGV (Figure 3-9).

The filtered and unfiltered arsenic (As) concentrations were very similar. Samples ranged from 1.3 to 1.9 µg/L, with all recorded concentrations below the ANZG (2018) DGV of 4.5 µg/L (Figure 3-9).

Filtered and unfiltered lead (Pb) concentrations ranged from <0.1 to 5.4 µg/L (Figure 3-9). Ten unfiltered lead samples below the LoR, whilst six filtered lead samples were below the LoR. One sample of filtered lead (OP5S) was above the ANZG (2018) DGV of 4.4 µg/L in slightly to moderately disturbed marine offshore ecosystems, at the 95% species protection level.

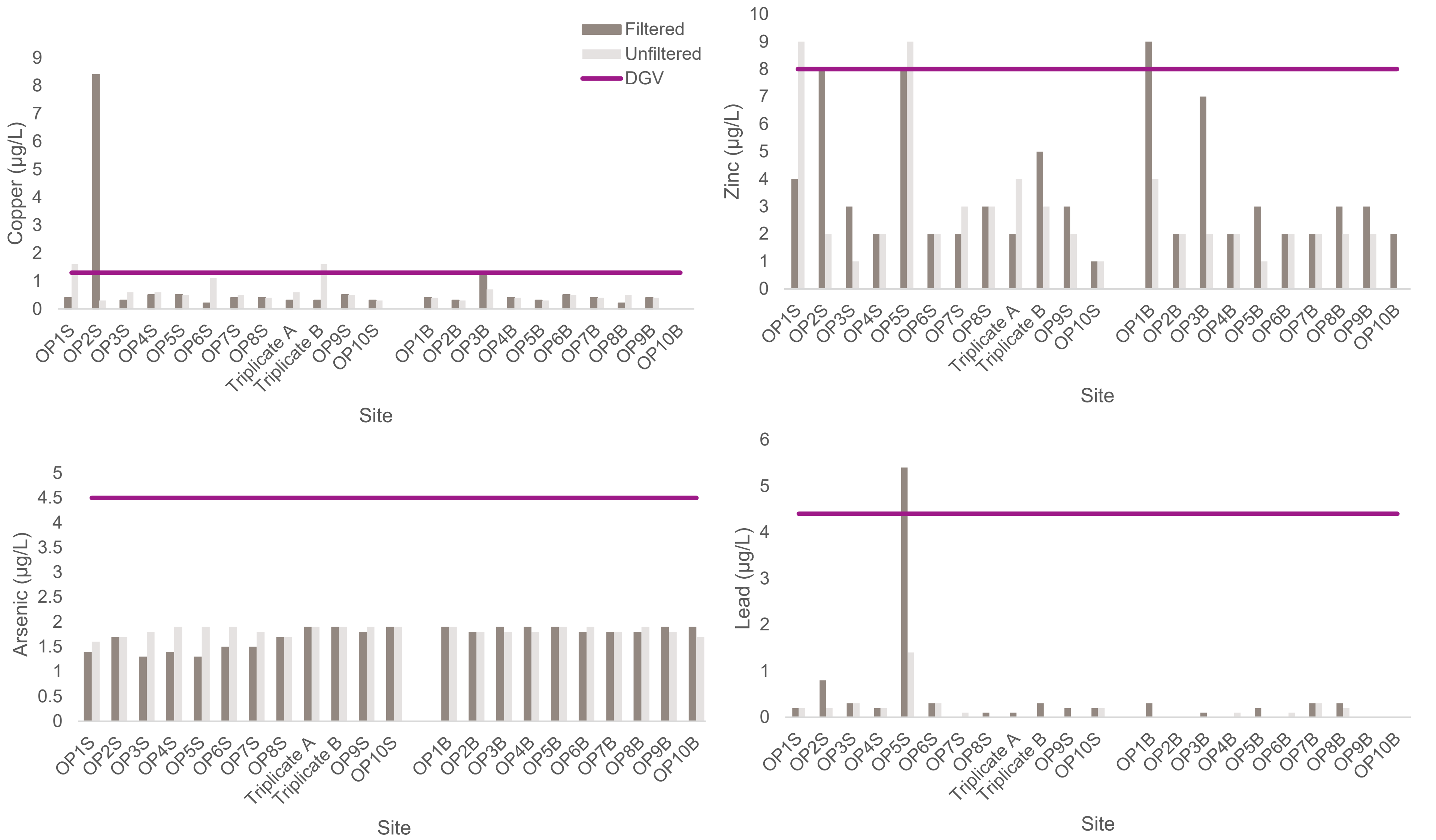


Figure 3-9: Filtered and unfiltered metal concentrations above LoRs from the Offshore Pipeline route (from south to north)

3.3.1.3 Nutrients and pigments

3.3.1.3.1 Nitrogen

The test for total nitrogen provided data for all nitrogen compounds in the water samples, namely nitrite (NO_2), nitrate (NO_3), ammonia (NH_4+) and organic nitrogen compounds.

Nitrite and nitrate were recorded at detectable levels at all sites, except for site OP8S/B. Nitrite and nitrate were recorded in bottom water samples only, with all surface samples being below the LoR. Nitrite and nitrate were recorded at concentrations of <2 to 15 µg.N/L in the bottom water samples.

Ammonia was detected in 11 samples, with ten of those being bottom (near seabed) samples. Only one surface sample had detectable concentrations of Ammonia (OP5S), with a concentration of 7 µg.N/L being recorded from this sample. All samples were below the ANZG (2018) default species protection guideline value of 910 µg.N/L for ammonia in slightly to moderately disturbed marine offshore ecosystems, which have a 95% species protection level.

Total nitrogen concentrations indicated the presence of other organic nitrogen compounds, with no samples (excluding the field and transport blanks) being below the LoR concentration of 50 µg.N/L. Total nitrogen concentrations ranged from 80 to 150 µg.N/L. There were 20 samples that were found to have met or exceeded the ANZG (2018) DGV of 100 µg.N/L for total nitrogen in slightly disturbed tropical Australian marine offshore ecosystems (Figure 3-10).

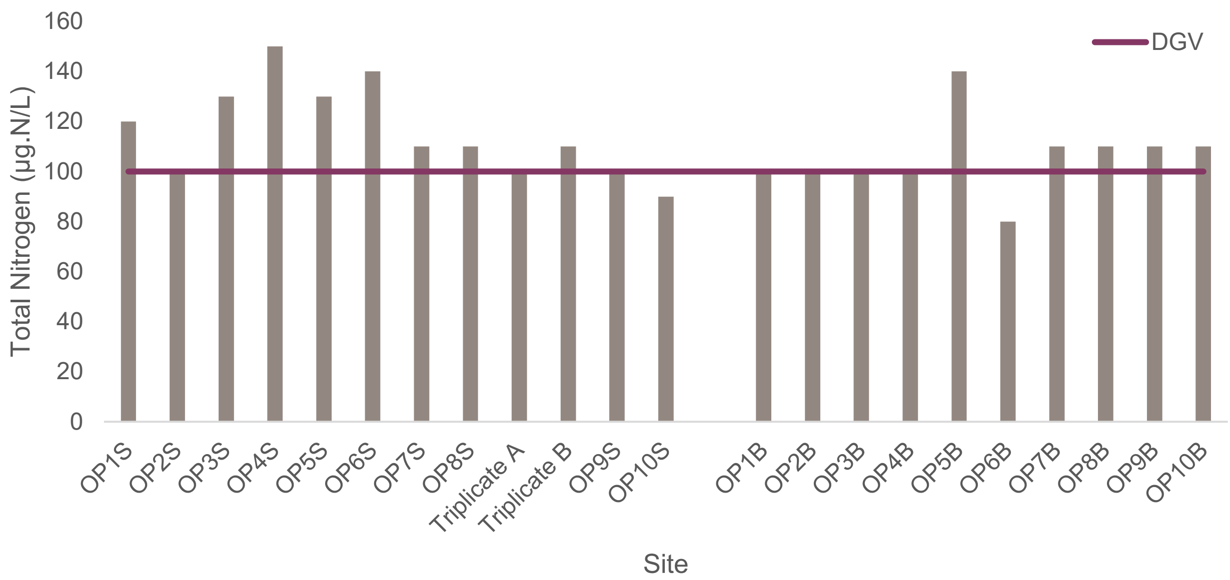


Figure 3-10: Surface and bottom total nitrogen concentrations along the offshore pipeline route

3.3.1.3.2 Phosphorus

The results for total phosphorus comprise the concentration of phosphorus that occurs in orthophosphate and organic phosphate compounds.

Orthophosphate (filterable reactive phosphorus) concentrations ranged from <2 to 8 µg.P/L. All but two samples were above the LoR, and both of these samples were surface samples (OP3S and OP4S). Eight samples exceeded the ANZG (2018) DGV of 5 µg.P/L for orthophosphate in slightly disturbed tropical Australian marine offshore ecosystems.

Total phosphorous concentrations ranged from 9 to 17 µg.P/L. Almost all samples, with the exception of three surface samples (OP1S, OP2S and OP3S), met or exceeded the ANZG (2018) DGV of 10 µg.P/L for total phosphorus in slightly disturbed tropical Australian marine offshore ecosystems (Figure 3-11).

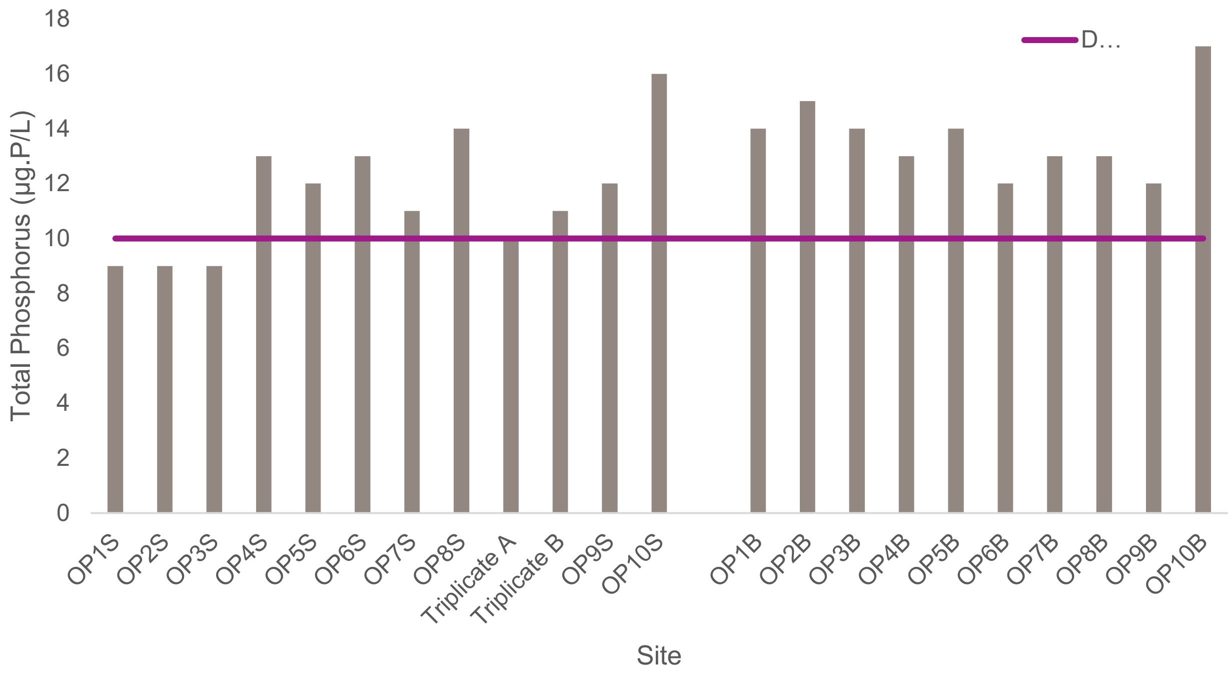


Figure 3-11: Surface and bottom total phosphorus concentrations along the offshore pipeline route

3.3.1.3.3 Pigments

Chlorophyll-a concentrations were used as an indicator of the likely level of phytoplankton biomass across the offshore pipeline area. Chlorophyll-a concentrations ranged from 0.4 to 1.5 µg/L (Figure 3-12). All concentrations were below the ANZG (2018) default guideline value of 9 µg/L for chlorophyll-a in slightly disturbed tropical Australian marine offshore ecosystems. Concentrations were variable across surface and bottom samples.

Phaeophytin-a was also sampled as this pigment is a breakdown product of chlorophyll-a and can be used to indicate if phytoplankton are blooming or declining. Phaeophytin-a was detected in 10 samples, the majority of which were at the surface (Figure 3-12). Concentrations ranged from <0.2 µg/L (i.e., below the LoR) to 0.6 µg/L. There is no ANZG (2018) default guideline value for phaeophytin-a.

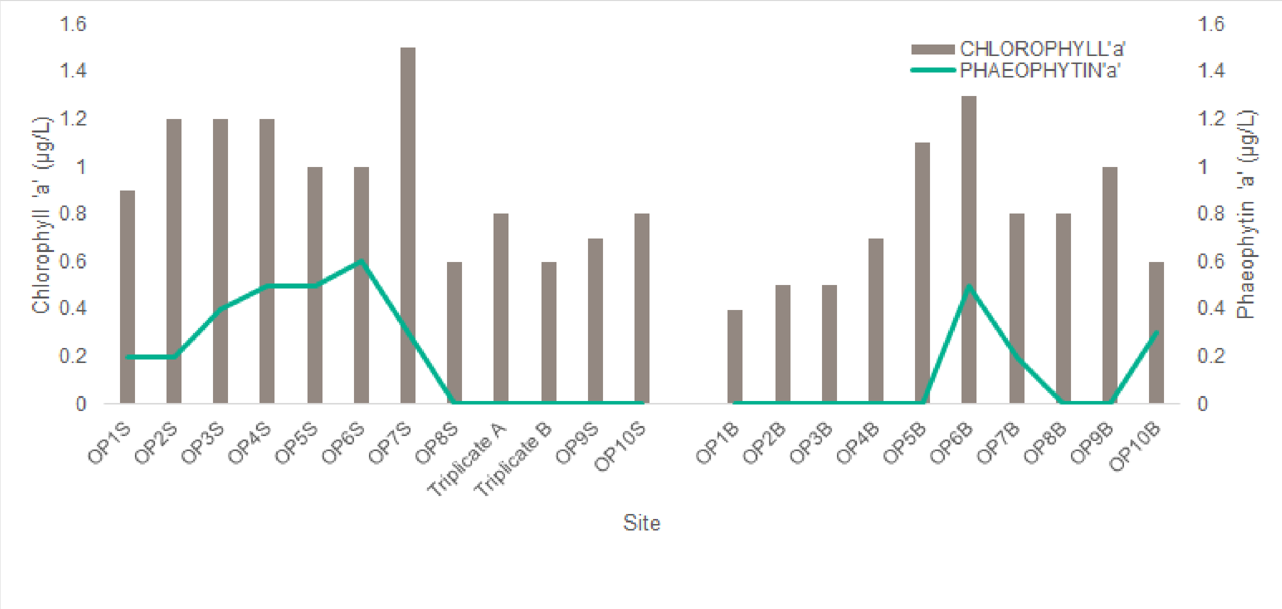


Figure 3-12: Surface and bottom Chlorophyll-a and Phaeophytin-a concentrations along the offshore pipeline route

3.3.1.3.4 Total suspended solids

Total suspended solid (TSS) concentrations were all above the LoR (0.5 mg/L) and ranged from 1.7 to 8.6 mg/L. Most sites had TSS between 1.7 and 4 mg/L, however site OP10S/B was much higher, with 8.6 mg/L at the surface and 7.7 mg/L at the bottom. OP10S/B was the closest water quality site to Darwin Harbour but was sampled on an incoming tide. There was no correlation between depth and TSS.

3.3.2 Spoil Ground

3.3.2.1 Hydrocarbons

The offshore pipeline total recoverable hydrocarbon (TRH) and BTEXN concentrations were below the LoR for all samples (Appendix B). The offshore pipeline samples were, therefore, not tested for polycyclic aromatic hydrocarbons (PAHs).

3.3.2.2 Metals

Five of the filtered and unfiltered metals and metalloids were below the LoR concentrations for all sites. These were cadmium (Cd), chromium (Cr), cobalt (Co), nickel (Ni) and mercury (Hg). Due to an issue with the sample jar, unfiltered metals were not analysed for Triplicate D.

Filtered and unfiltered copper (Cu) concentrations ranged from <0.2 to 0.6 µg/L (Figure 3-13). Only two unfiltered copper samples were below the LoR (Triplicate C and SG7B), while five filtered copper samples were below the LoR (SG12S, Triplicate D, SG13S, SG4S and SG7B). None of the copper samples were above the ANZG (2018) DGV of 1.3 µg/L, in slightly to moderately disturbed marine offshore ecosystems, which have a 95% species protection level (Figure 3-13).

Unfiltered zinc (Zn) concentrations ranged from <1 to 2 µg/L and were below the ANZG (2018) DGV of 8 µg/L for all sites. Filtered zinc concentrations ranged from 2 to 18 µg/L, four of these samples were at or above the DGV (Figure 3-13). The highest zinc concentration was at SG4B.

The filtered and unfiltered arsenic (As) concentrations were above the LoR and were very similar. Samples ranged from 1.6 to 1.9 µg/L, with all recorded concentrations below the ANZG (2018) guideline value of 4.5 µg/L (Figure 3-13).

Filtered and unfiltered lead (Pb) concentrations ranged from <0.1 to 0.4 µg/L (Figure 3-13). Only three unfiltered lead samples were below the LoR (Triplicate C, SG8S and SG1B), while six filtered lead samples were below the LoR (SG12S, Triplicate C, Triplicate D, SG8S, SG4S, SG13B and SG8B). All lead samples were well below the ANZG (2018) DGV of 4.4 µg/L in slightly to moderately disturbed marine offshore ecosystems, which have a 95% species protection level.

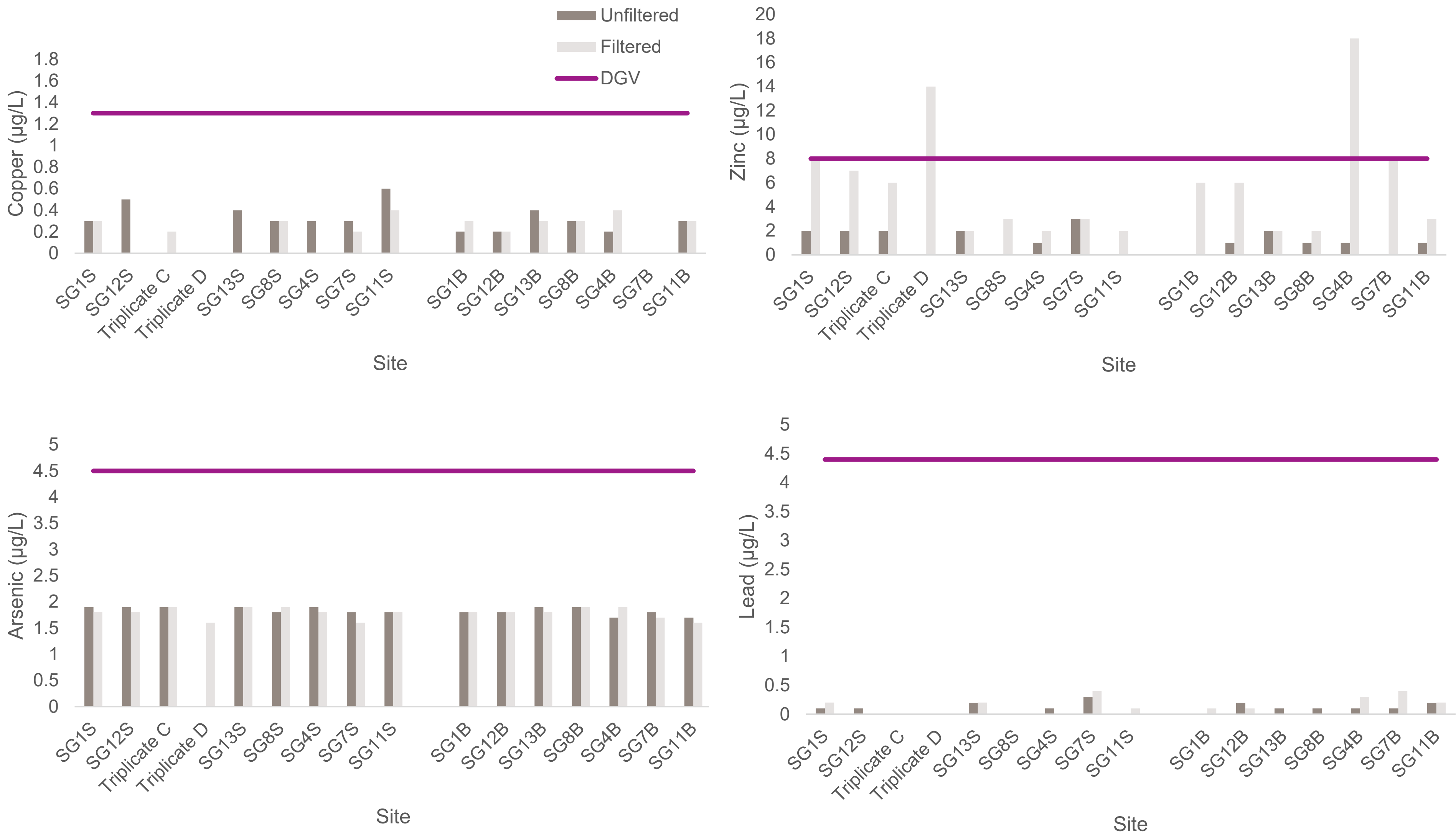


Figure 3-13: Filtered and unfiltered metal concentrations from the Spoil Ground

3.3.2.3 Nutrients and pigments

3.3.2.3.1 Nitrogen

Nitrite and nitrate were only recorded at concentrations above the LoR at two of the Spoil Ground sites, with both being bottom samples. These nitrate concentrations were 12 µg.N/L at SG12B and 4 µg.N/L at SG11B. All surface samples were below the LOR.

Ammonia concentrations were below the LoR for all but three samples. Ammonia was only detected in near-seabed water samples (SG12B, SG4B and SG11B). The Ammonia concentrations in these samples ranged from 3 µg.N/L to 13 µg.N/L. All samples were below the ANZG (2018) default species protection guideline value of 910 µg.N/L for ammonia in slightly to moderately disturbed marine offshore ecosystems, which have a 95% species protection level.

Total nitrogen concentrations indicated the presence of other organic nitrogen compounds, with no samples (excluding the field and transport blanks) being below the LoR of 50 µg.N/L. All but one sample (SG8S) were at or above the ANZG (2018) DGV of 100 µg.N/L total nitrogen in slightly disturbed tropical Australian marine offshore ecosystems.

3.3.2.3.2 Phosphorus

Orthophosphate (filterable reactive phosphorus) concentrations ranged from 4 to 9 µg.P/L. All samples were above the LoR. Eleven samples exceeded the ANZG (2018) DGV of 5 µg.P/L for orthophosphate in slightly disturbed tropical Australian marine offshore ecosystems.

Total phosphorous concentrations ranged from 11 to 16 µg.P/L. All samples exceeded the ANZG (2018) DGV of 10 µg.P/L for total phosphorus in slightly disturbed tropical Australian marine offshore ecosystems.

3.3.2.3.3 Pigments

Chlorophyll-a concentrations ranged from 0.2 to 0.5 µg/L at the Spoil Ground sites. All concentrations were below the ANZG (2018) default guideline value of 9 µg/L for chlorophyll-a in slightly disturbed tropical Australian marine offshore ecosystems. Concentrations were variable across surface and bottom samples.

Phaeophytin-a was also sampled as this pigment is a breakdown product of chlorophyll-a and can be used to indicate if phytoplankton are blooming or declining. Phaeophytin-a was not detected above the LoR for any of the Spoil Ground sites.

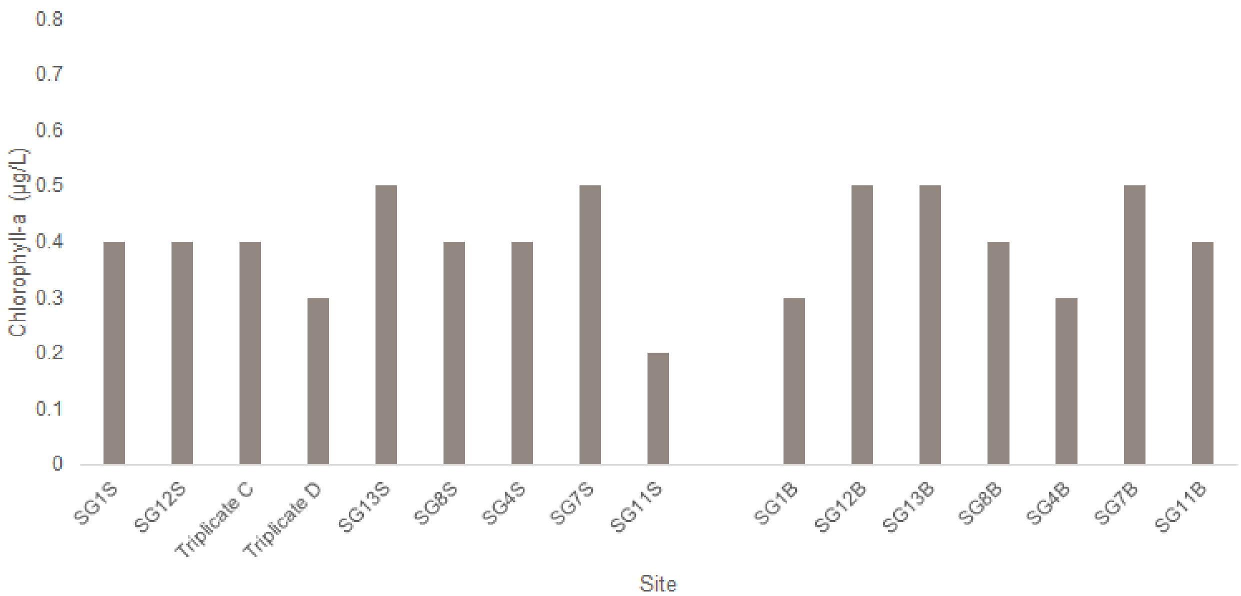


Figure 3-14: Surface and bottom chlorophyll-a concentrations at the Spoil Ground

3.3.2.3.4 Total suspended solids

Total suspended solid (TSS) concentrations were all above the LoR (0.5 mg/L) and ranged from 1.4 to 6.2 mg/L. There was no clear difference found in the TSS between surface and bottom samples.

3.4 Quality control

The hydrocarbon concentrations for both water and sediment samples show no difference between the triplicates and the original sample sites. All blank samples were below the limit of reporting for hydrocarbons.

HOLD- INTERIM DRAFT TO BE COMPLETED

Appendix E – Protected Matters Search Tool (PMST) Results

Australian Government

Department of Agriculture, Water and the Environment

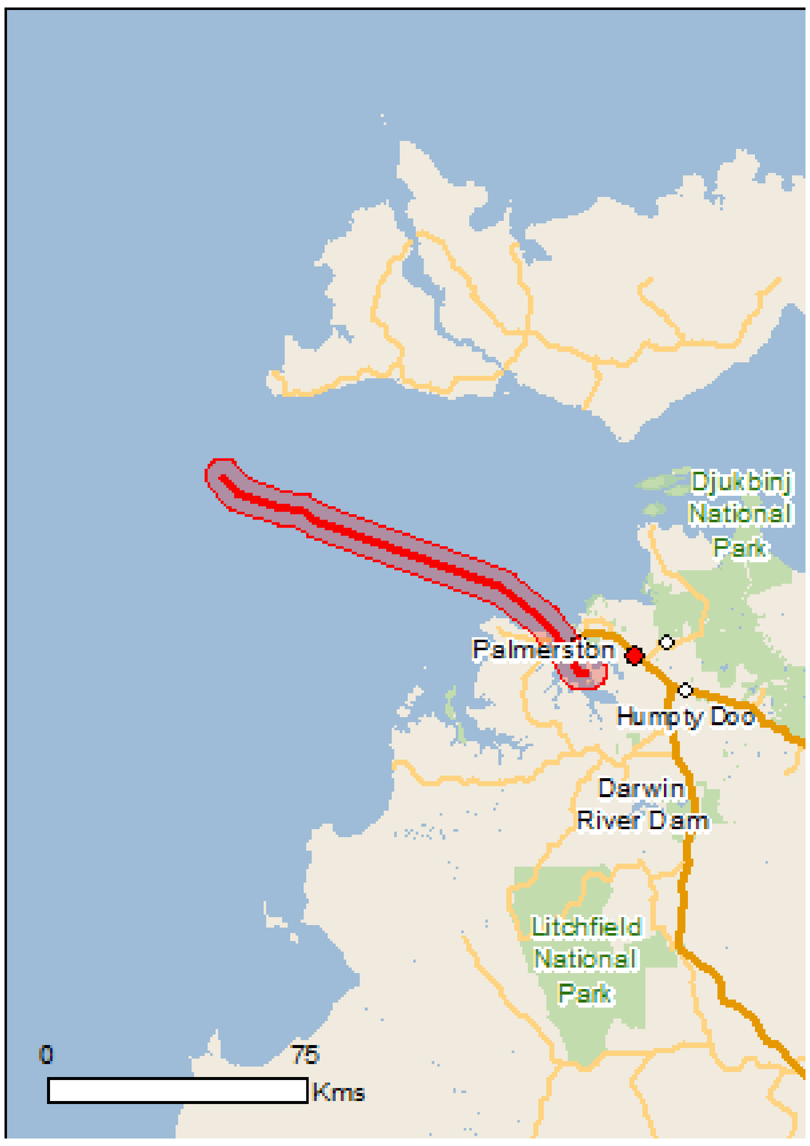
EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

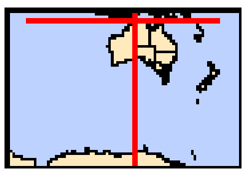
Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 24/10/21 16:43:28



Coordinates

Buffer: 5.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	1
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	41
Listed Migratory Species:	74

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	9
Commonwealth Heritage Places:	3
Listed Marine Species:	110
Whales and Other Cetaceans:	15
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	1
Regional Forest Agreements:	None
Invasive Species:	30
Nationally Important Wetlands:	1
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

Name
EEZ and Territorial Sea

Marine Regions [Resource Information]

If you are planning to undertake action in an area in or close to the Commonwealth Marine Area, and a marine bioregional plan has been prepared for the Commonwealth Marine Area in that area, the marine bioregional plan may inform your decision as to whether to refer your proposed action under the EPBC Act.

Name
North

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Species or species habitat known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Foraging, feeding or related behaviour known to occur within area
Erythrotriorchis radiatus Red Goshawk [942]	Vulnerable	Species or species habitat known to occur within area
Erythrura gouldiae Gouldian Finch [413]	Endangered	Species or species habitat known to occur within area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat likely to occur within area
Geophaps smithii smithii Partridge Pigeon (eastern) [64441]	Vulnerable	Species or species habitat known to occur

Name	Status	Type of Presence
		within area
Limosa lapponica baueri Nunivak Bar-tailed Godwit, Western Alaskan Bar-tailed Godwit [86380]	Vulnerable	Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Tyto novaehollandiae kimberli Masked Owl (northern) [26048]	Vulnerable	Species or species habitat likely to occur within area
Mammals		
Antechinus bellus Fawn Antechinus [344]	Vulnerable	Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Species or species habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat may occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Species or species habitat may occur within area
Conilurus penicillatus Brush-tailed Rabbit-rat, Brush-tailed Tree-rat, Pakooma [132]	Vulnerable	Species or species habitat may occur within area
Dasyurus hallucatus Northern Quoll, Digul [Gogo-Yimidir], Wijingadda [Dambimangari], Wiminji [Martu] [331]	Endangered	Species or species habitat known to occur within area
Macroderma gigas Ghost Bat [174]	Vulnerable	Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat likely to occur within area
Mesembriomys gouldii gouldii Black-footed Tree-rat (Kimberley and mainland Northern Territory), Djintamoonga, Manbul [87618]	Endangered	Species or species habitat known to occur within area
Petrogale concinna canescens Nabarlek (Top End) [87606]	Endangered	Species or species habitat likely to occur within area
Phascogale pirata Northern Brush-tailed Phascogale [82954]	Vulnerable	Species or species habitat likely to occur within area
Saccolaimus saccolaimus nudicluniatus Bare-rumped Sheath-tailed Bat, Bare-rumped Sheathtail Bat [66889]	Vulnerable	Species or species habitat likely to occur within area
Trichosurus vulpecula arnhemensis Northern Brushtail Possum [83091]	Vulnerable	Species or species habitat known to occur within area
Xeromys myoides Water Mouse, False Water Rat, Yirrkoo [66]	Vulnerable	Species or species habitat likely to occur

Name	Status	Type of Presence
		within area
Reptiles		
Acanthophis hawkei Plains Death Adder [83821]	Vulnerable	Species or species habitat known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Breeding likely to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat known to occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Breeding known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Sharks		
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area
Glyphis garricki Northern River Shark, New Guinea River Shark [82454]	Endangered	Species or species habitat may occur within area
Glyphis glyphis Speartooth Shark [82453]	Critically Endangered	Species or species habitat may occur within area
Pristis clavata Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Species or species habitat known to occur within area
Pristis pristis Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Anous stolidus Common Noddy [825]		Species or species habitat likely to occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat known to occur within area

Name	Threatened	Type of Presence
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat known to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat known to occur within area
Sternula albifrons Little Tern [82849]		Species or species habitat may occur within area
Migratory Marine Species		
Anoxypristis cuspidata Narrow Sawfish, Knifetooth Sawfish [68448]		Species or species habitat known to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Species or species habitat may occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat may occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Species or species habitat may occur within area
Carcharhinus longimanus Oceanic Whitetip Shark [84108]		Species or species habitat may occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Crocodylus porosus Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Breeding likely to occur within area
Dugong dugon Dugong [28]		Species or species habitat known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat known to occur within area
Isurus oxyrinchus Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
Isurus paucus Longfin Mako [82947]		Species or species habitat likely to occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Breeding known to occur

Name	Threatened	Type of Presence
		within area
Manta alfredi Reef Manta Ray, Coastal Manta Ray, Inshore Manta Ray, Prince Alfred's Ray, Resident Manta Ray [84994]		Species or species habitat may occur within area
Manta birostris Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray [84995]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat likely to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Orcaella heinsohni Australian Snubfin Dolphin [81322]		Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Pristis clavata Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Species or species habitat known to occur within area
Pristis pristis Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Breeding known to occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat known to occur within area
Migratory Terrestrial Species		
Cecropis daurica Red-rumped Swallow [80610]		Species or species habitat known to occur within area
Cuculus optatus Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat known to occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat known to occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat known to occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat known to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat likely to occur within area
Migratory Wetlands Species		

Name	Threatened	Type of Presence
Acrocephalus orientalis Oriental Reed-Warbler [59570]		Species or species habitat may occur within area
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Arenaria interpres Ruddy Turnstone [872]		Foraging, feeding or related behaviour known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Foraging, feeding or related behaviour known to occur within area
Calidris alba Sanderling [875]		Foraging, feeding or related behaviour known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Calidris ruficollis Red-necked Stint [860]		Foraging, feeding or related behaviour known to occur within area
Calidris subminuta Long-toed Stint [861]		Species or species habitat known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Species or species habitat known to occur within area
Charadrius dubius Little Ringed Plover [896]		Species or species habitat known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Foraging, feeding or related behaviour known to occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat known to occur within area
Gallinago megala Swinhoe's Snipe [864]		Species or species habitat known to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Foraging, feeding or related behaviour likely to occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat known to occur within area

Name	Threatened	Type of Presence
Limicola falcinellus Broad-billed Sandpiper [842]		Species or species habitat known to occur within area
Limnodromus semipalmatus Asian Dowitcher [843]		Species or species habitat likely to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]		Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Species or species habitat known to occur within area
Numenius phaeopus Whimbrel [849]		Foraging, feeding or related behaviour known to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Foraging, feeding or related behaviour known to occur within area
Pluvialis squatarola Grey Plover [865]		Foraging, feeding or related behaviour known to occur within area
Tringa brevipes Grey-tailed Tattler [851]		Foraging, feeding or related behaviour known to occur within area
Tringa glareola Wood Sandpiper [829]		Species or species habitat known to occur within area
Tringa incana Wandering Tattler [831]		Species or species habitat known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Species or species habitat known to occur within area
Xenus cinereus Terek Sandpiper [59300]		Foraging, feeding or related behaviour known to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Name
Commonwealth Land -
Commonwealth Land - Australian Government Solicitor
Commonwealth Land - Deputy Crown Solicitor
Defence - AUSTRALIAN ARMY BAND - DARWIN
Defence - DEFENCE FORCE CAREERS REFERENCE CENTRE
Defence - Esanda Builidng
Defence - LARRAKEYAH BARRACKS
Defence - Patrol Boat Base (DARWIN NAVAL BASE)
Defence - STOKES HILL OIL FUEL INSTALLATION

Commonwealth Heritage Places [Resource Information]

Name	State	Status
Historic		
Larrakeyah Barracks Headquarters Building	NT	Listed place
Larrakeyah Barracks Precinct	NT	Listed place
Larrakeyah Barracks Sergeants Mess	NT	Listed place

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Acrocephalus orientalis Oriental Reed-Warbler [59570]		Species or species habitat may occur within area
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Anous stolidus Common Noddy [825]		Species or species habitat likely to occur within area
Anseranas semipalmata Magpie Goose [978]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Arenaria interpres Ruddy Turnstone [872]		Foraging, feeding or related behaviour known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Foraging, feeding or related behaviour known to occur within area
Calidris alba Sanderling [875]		Foraging, feeding or related behaviour known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species

Name	Threatened	Type of Presence
		habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Calidris ruficollis Red-necked Stint [860]		Foraging, feeding or related behaviour known to occur within area
Calidris subminuta Long-toed Stint [861]		Species or species habitat known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Species or species habitat known to occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat known to occur within area
Charadrius dubius Little Ringed Plover [896]		Species or species habitat known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Foraging, feeding or related behaviour known to occur within area
Charadrius ruficapillus Red-capped Plover [881]		Species or species habitat known to occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat known to occur within area
Chrysococcyx osculans Black-eared Cuckoo [705]		Species or species habitat likely to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat known to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat known to occur within area
Gallinago megala Swinhoe's Snipe [864]		Species or species habitat known to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Foraging, feeding or related behaviour likely to occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat known to occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Heteroscelus brevipes Grey-tailed Tattler [59311]		Foraging, feeding or related behaviour known

Name	Threatened	Type of Presence
		to occur within area
Heteroscelus incanus Wandering Tattler [59547]		Species or species habitat known to occur within area
Himantopus himantopus Pied Stilt, Black-winged Stilt [870]		Species or species habitat known to occur within area
Hirundo daurica Red-rumped Swallow [59480]		Species or species habitat known to occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat known to occur within area
Limicola falcinellus Broad-billed Sandpiper [842]		Species or species habitat known to occur within area
Limnodromus semipalmatus Asian Dowitcher [843]		Species or species habitat likely to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]		Species or species habitat known to occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat known to occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Species or species habitat known to occur within area
Numenius phaeopus Whimbrel [849]		Foraging, feeding or related behaviour known to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Foraging, feeding or related behaviour known to occur within area
Pluvialis squatarola Grey Plover [865]		Foraging, feeding or related behaviour known to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat may occur within area
Sterna albifrons Little Tern [813]		Species or species habitat may occur within area
Stiltia isabella Australian Pratincole [818]		Species or species habitat known to occur within area
Tringa glareola Wood Sandpiper [829]		Species or species habitat known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Species or species habitat known to occur within area
Xenus cinereus Terek Sandpiper [59300]		Foraging, feeding or related behaviour known to occur within area
Fish		
Campichthys tricarinatus Three-keel Pipefish [66192]		Species or species habitat may occur within area
Choeroichthys brachysoma Pacific Short-bodied Pipefish, Short-bodied Pipefish [66194]		Species or species habitat may occur within area
Choeroichthys suillus Pig-snouted Pipefish [66198]		Species or species habitat may occur within area
Corythoichthys amplexus Fijian Banded Pipefish, Brown-banded Pipefish [66199]		Species or species habitat may occur within area
Corythoichthys flavofasciatus Reticulate Pipefish, Yellow-banded Pipefish, Network Pipefish [66200]		Species or species habitat may occur within area
Corythoichthys haematopterus Reef-top Pipefish [66201]		Species or species habitat may occur within area
Corythoichthys schultzi Schultz's Pipefish [66205]		Species or species habitat may occur within area
Doryrhamphus excisus Bluestripe Pipefish, Indian Blue-stripe Pipefish, Pacific Blue-stripe Pipefish [66211]		Species or species habitat may occur within area
Doryrhamphus janssi Cleaner Pipefish, Janss' Pipefish [66212]		Species or species habitat may occur within area
Festucalex cinctus Girdled Pipefish [66214]		Species or species habitat may occur within area
Halicampus brocki Brock's Pipefish [66219]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Halicampus grayi Mud Pipefish, Gray's Pipefish [66221]		Species or species habitat may occur within area
Halicampus spinirostris Spiny-snout Pipefish [66225]		Species or species habitat may occur within area
Haliichthys taeniophorus Ribboned Pipehorse, Ribboned Seadragon [66226]		Species or species habitat may occur within area
Hippichthys cyanospilos Blue-speckled Pipefish, Blue-spotted Pipefish [66228]		Species or species habitat may occur within area
Hippichthys parvicarinatus Short-keel Pipefish, Short-keeled Pipefish [66230]		Species or species habitat may occur within area
Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish [66231]		Species or species habitat may occur within area
Hippocampus histrix Spiny Seahorse, Thorny Seahorse [66236]		Species or species habitat may occur within area
Hippocampus kuda Spotted Seahorse, Yellow Seahorse [66237]		Species or species habitat may occur within area
Hippocampus planifrons Flat-face Seahorse [66238]		Species or species habitat may occur within area
Hippocampus spinosissimus Hedgehog Seahorse [66239]		Species or species habitat may occur within area
Micrognathus micronotopterus Tidepool Pipefish [66255]		Species or species habitat may occur within area
Solegnathus hardwickii Pallid Pipehorse, Hardwick's Pipehorse [66272]		Species or species habitat may occur within area
Solegnathus lettiensis Gunther's Pipehorse, Indonesian Pipefish [66273]		Species or species habitat may occur within area
Solenostomus cyanopterus Robust Ghostpipefish, Blue-finned Ghost Pipefish, [66183]		Species or species habitat may occur within area
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area
Trachyrhamphus bicoarctatus Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280]		Species or species habitat may occur within area
Trachyrhamphus longirostris Straightstick Pipefish, Long-nosed Pipefish, Straight Stick Pipefish [66281]		Species or species habitat may occur within area
Mammals		
Dugong dugon Dugong [28]		Species or species habitat known to occur within area

Name	Threatened	Type of Presence
Reptiles		
Acalyptophis peronii Horned Seasnake [1114]		Species or species habitat may occur within area
Aipysurus duboisii Dubois' Seasnake [1116]		Species or species habitat may occur within area
Aipysurus eydouxii Spine-tailed Seasnake [1117]		Species or species habitat may occur within area
Aipysurus laevis Olive Seasnake [1120]		Species or species habitat may occur within area
Astrotia stokesii Stokes' Seasnake [1122]		Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Crocodylus johnstoni Freshwater Crocodile, Johnston's Crocodile, Johnstone's Crocodile [1773]		Species or species habitat may occur within area
Crocodylus porosus Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Breeding likely to occur within area
Disteira kingii Spectacled Seasnake [1123]		Species or species habitat may occur within area
Disteira major Olive-headed Seasnake [1124]		Species or species habitat may occur within area
Enhydrina schistosa Beaked Seasnake [1126]		Species or species habitat may occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat known to occur within area
Hydrelaps darwiniensis Black-ringed Seasnake [1100]		Species or species habitat may occur within area
Hydrophis atriceps Black-headed Seasnake [1101]		Species or species habitat may occur within area
Hydrophis coggeri Slender-necked Seasnake [25925]		Species or species habitat may occur within area
Hydrophis elegans Elegant Seasnake [1104]		Species or species habitat may occur within area
Hydrophis inornatus Plain Seasnake [1107]		Species or species

Name	Threatened	Type of Presence
		habitat may occur within area
Hydrophis mcdowelli null [25926]		Species or species habitat may occur within area
Hydrophis ornatus Spotted Seasnake, Ornate Reef Seasnake [1111]		Species or species habitat may occur within area
Hydrophis pacificus Large-headed Seasnake, Pacific Seasnake [1112]		Species or species habitat may occur within area
Lapemis hardwickii Spine-bellied Seasnake [1113]		Species or species habitat may occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Breeding known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Parahydrophis mertoni Northern Mangrove Seasnake [1090]		Species or species habitat may occur within area
Pelamis platurus Yellow-bellied Seasnake [1091]		Species or species habitat may occur within area

Whales and other Cetaceans [Resource Information]

Name	Status	Type of Presence
Mammals		
Balaenoptera borealis Sei Whale [34]	Vulnerable	Species or species habitat may occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat may occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Species or species habitat may occur within area
Delphinus delphis Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat likely to occur within area
Orcaella brevirostris Irrawaddy Dolphin [45]		Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area

Name	Status	Type of Presence
Pseudorca crassidens False Killer Whale [48]		Species or species habitat likely to occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Breeding known to occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat known to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area

Extra Information

State and Territory Reserves [Resource Information]

Name	State
George Brown Darwin	NT

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Acridotheres tristis Common Myna, Indian Myna [387]		Species or species habitat likely to occur within area
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Passer montanus Eurasian Tree Sparrow [406]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Frogs		
Rhinella marina Cane Toad [83218]		Species or species habitat known to occur within area

Name	Status	Type of Presence
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Bubalus bubalis Water Buffalo, Swamp Buffalo [1]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Equus caballus Horse [5]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Plants		
Andropogon gayanus Gamba Grass [66895]		Species or species habitat likely to occur within area
Annona glabra Pond Apple, Pond-apple Tree, Alligator Apple, Bullock's Heart, Cherimoya, Monkey Apple, Bobwood, Corkwood [6311]		Species or species habitat may occur within area
Brachiaria mutica Para Grass [5879]		Species or species habitat likely to occur within area
Cabomba caroliniana Cabomba, Fanwort, Carolina Watershield, Fish Grass, Washington Grass, Watershield, Carolina Fanwort, Common Cabomba [5171]		Species or species habitat likely to occur within area
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat may occur within area
Dolichandra unguis-cati Cat's Claw Vine, Yellow Trumpet Vine, Cat's Claw Creeper, Funnel Creeper [85119]		Species or species habitat likely to occur within area
Hymenachne amplexicaulis Hymenachne, Olive Hymenachne, Water Stargrass, West Indian Grass, West Indian Marsh Grass [31754]		Species or species habitat likely to occur within area
Jatropha gossypifolia Cotton-leaved Physic-Nut, Bellyache Bush, Cotton-leaf Physic Nut, Cotton-leaf Jatropha, Black Physic Nut [7507]		Species or species habitat likely to occur within area
Lantana camara Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species habitat likely to occur within area
Mimosa pigra Mimosa, Giant Mimosa, Giant Sensitive Plant,		Species or species

Name	Status	Type of Presence
ThornySensitive Plant, Black Mimosa, Catclaw Mimosa, Bashful Plant [11223]		habitat likely to occur within area
Parkinsonia aculeata		
Parkinsonia, Jerusalem Thorn, Jelly Bean Tree, Horse Bean [12301]		Species or species habitat likely to occur within area
Pennisetum polystachyon		
Mission Grass, Perennial Mission Grass, Missiongrass, Feathery Pennisetum, Feather Pennisetum, Thin Napier Grass, West Indian Pennisetum, Blue Buffel Grass [21194]		Species or species habitat likely to occur within area
Salvinia molesta		
Salvinia, Giant Salvinia, Aquarium Watermoss, Kariba Weed [13665]		Species or species habitat likely to occur within area
Reptiles		
Hemidactylus frenatus		
Asian House Gecko [1708]		Species or species habitat likely to occur within area
Lepidodactylus lugubris		
Mourning Gecko [1712]		Species or species habitat likely to occur within area
Ramphotyphlops braminus		
Flowerpot Blind Snake, Brahminy Blind Snake, Cacing Besi [1258]		Species or species habitat likely to occur within area

Nationally Important Wetlands [Resource Information]

Name	State
Port Darwin	NT

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-12.52496 130.86426,-12.52855 130.84265,-12.51948 130.83031,-12.47611 130.81071,-12.437 130.78192,-12.39655 130.74923,-12.3918 130.74381,-12.31363 130.64517,-12.31029 130.6401,-12.14051 130.15147,-12.11228 130.11083,-12.10622 130.05589,-12.06871 129.94381,-12.02289 129.90689

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

- -Office of Environment and Heritage, New South Wales
- -Department of Environment and Primary Industries, Victoria
- -Department of Primary Industries, Parks, Water and Environment, Tasmania
- -Department of Environment, Water and Natural Resources, South Australia
- -Department of Land and Resource Management, Northern Territory
- -Department of Environmental and Heritage Protection, Queensland
- -Department of Parks and Wildlife, Western Australia
- -Environment and Planning Directorate, ACT
- -Birdlife Australia
- -Australian Bird and Bat Banding Scheme
- -Australian National Wildlife Collection
- -Natural history museums of Australia
- -Museum Victoria
- -Australian Museum
- -South Australian Museum
- -Queensland Museum
- -Online Zoological Collections of Australian Museums
- -Queensland Herbarium
- -National Herbarium of NSW
- -Royal Botanic Gardens and National Herbarium of Victoria
- -Tasmanian Herbarium
- -State Herbarium of South Australia
- -Northern Territory Herbarium
- -Western Australian Herbarium
- -Australian National Herbarium, Canberra
- -University of New England
- -Ocean Biogeographic Information System
- -Australian Government, Department of Defence
- Forestry Corporation, NSW
- -Geoscience Australia
- -CSIRO
- -Australian Tropical Herbarium, Cairns
- -eBird Australia
- -Australian Government – Australian Antarctic Data Centre
- -Museum and Art Gallery of the Northern Territory
- -Australian Government National Environmental Science Program
- -Australian Institute of Marine Science
- -Reef Life Survey Australia
- -American Museum of Natural History
- -Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
- -Tasmanian Museum and Art Gallery, Hobart, Tasmania
- -Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

Department of Agriculture Water and the Environment
GPO Box 858
Canberra City ACT 2601 Australia
+61 2 6274 1111

Appendix F – NT EPA Pre-referral Screening Tool

NT EPA Pre-referral Screening Tool

The Northern Territory Environmental Protection Authority (NTEPA) has developed a screening tool to assist proponents in determining whether a proposed action requires formal referral (NTEPA, 2021a).

The screening tool is comprised of two parts namely, Part 1 (Screening questions, **Figure 1-1**) to determine whether the referral of the action should be considered further and Part 2 (Checklist) to assess the significance of impact to key environmental factors and requirement to refer the action. Part 1 and Part 2 have been completed below in the context of the Nearshore Barossa Gas Export Pipeline (GEP) Project (hereafter referred to as 'the Project').

1.1 Part 1 – Screening Questions

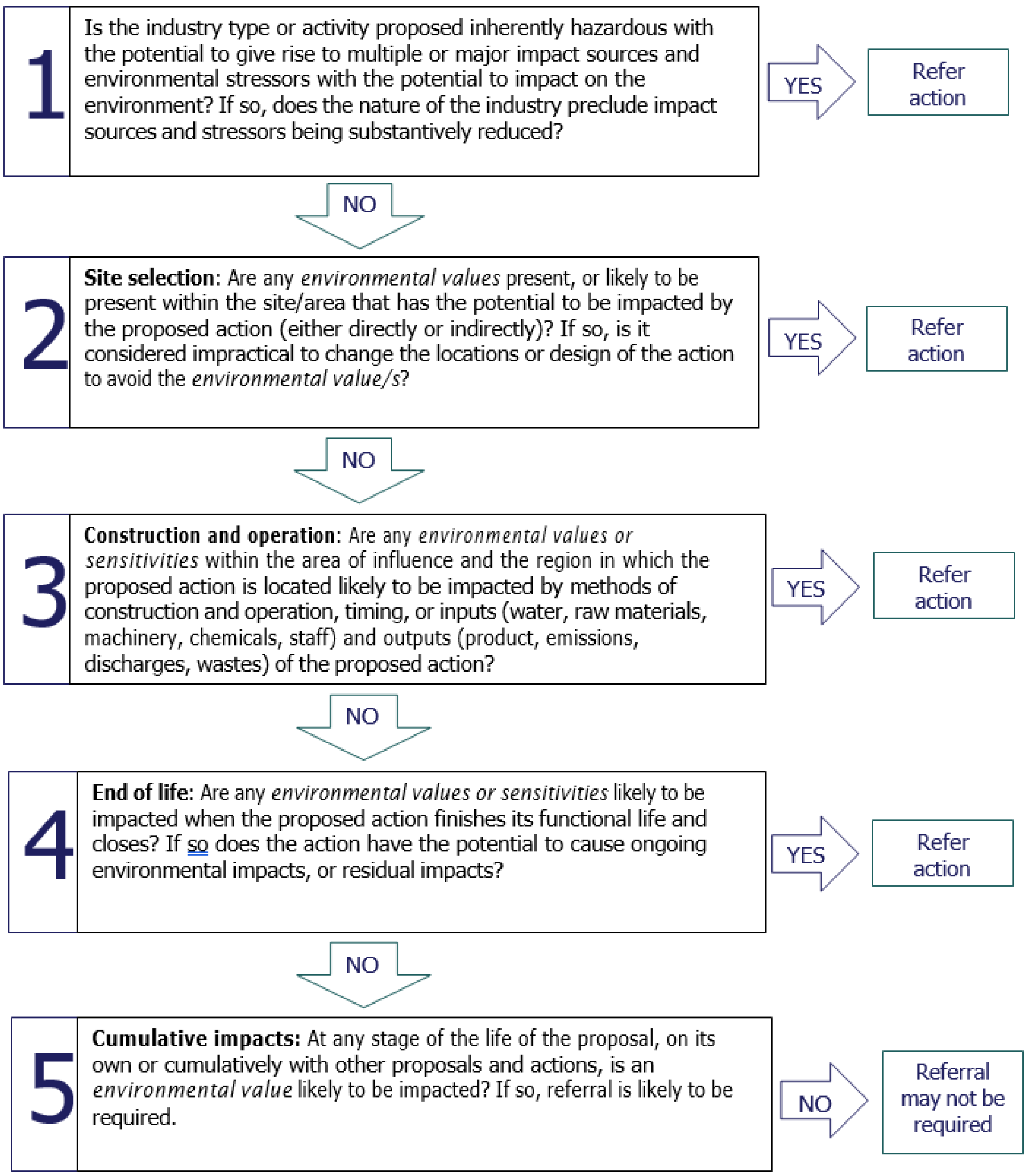


Figure 1-1 NT EPA Pre-referral screening tool Part 1 Screening questions for the Project (NTEPA, 2021a)

1.2 Part 2 – Checklist

Table 1-1 has been adapted from the NTEPA Pre-referral screening tool checklist (NTEPA, 2021a). It provides a preliminary evaluation of whether the Project has the potential to result in a significant impact on the environment and if formal referral to the NTEPA is necessary. **Table 1-1** has been reviewed within the context and framework of the NTEPA's environmental factors and objectives (NTEPA, 2021b).

The scope of the Project in the context of the NT EPA referral includes:

- Installation and operation of a dry gas pipeline (approximately 123 km in length) of which ~100 km is in NT Territorial waters;
- Sediment (borrow) may be required to provide backfill for trenching. This borrow ground will be located in the sand wave region at the mouth of the harbour.
- Spoil that is collected during the trenching activities will be disposed in a location north east of Darwin Harbour.
- Construction of a shore crossing and connection into the existing Darwin LNG facility.

For the purpose of the assessment, the Project Area has been defined to include the extent of all planned activities in the NT, as described in Section 3.5 of the Referral supporting information document, and encompasses activities of seabed preparation, sediment borrow and spoil disposal, installation and operation of the pipeline, onshore activities and support vessel movements in the immediate vicinity of the pipelay vessel (accounting for the full extents of anchor handling).

The Project Area has been sub-divided into three key 'areas' relevant to this referral; being:

- Offshore NT waters (e.g. NT waters outside Darwin Harbour). Note that this includes the proposed location for sediment borrow and spoil disposal;
- Darwin Harbour (e.g. waters within the Darwin Harbour Management Area); and
- Shore crossing location (including the short onshore section of the pipeline).

To undertake a preliminary evaluation of impacts on the NTEPA factors and objectives as a result of the Project, it is important to understand the definition of 'significant impact'. Refer to **Section 1.3** for the definition of a 'significant impact' in relation to the Northern Territory *Environment Protection Act 2019* (EP Act) and the NTEPA's contemporary guidance.

Explanation: *Use questions 1-5 from part 1 of the screening tool. Indicate answer to questions 1-5 in corresponding checkbox. The table below gives an indication of the possible environmental values for each environmental factor that should be considered when considering each question. If the answer to a question is 'yes', it is possible that the proposal may have the potential to have a significant impact on the environment and the proposal should be referred to the NT EPA (NTEPA, 2021a).*

Table 1--1 NTEPA Pre-referral screening tool Part 2 Checklist for the Project (adapted from NTEPA, 2021a)

Theme	Environmental factor and objective	Indicative environmental values and sensitivities relevant to each environmental factor	Summary of key environmental values and sensitivities of relevance to the Project	Proponent's answer to screening questions 1-5. If answer is 'yes' referral is required (Yes/ No/ Uncertain or Not Applicable (N/A))					Preliminary evaluation of significance (Nature, scale, context and sensitivity; refer definition provided below table)
				Q1	Q2	Q3	Q4	Q5	
LAND	1) Landforms <u>Objective</u>: Conserve the variety and integrity of distinctive physical landforms.	• distinctive features in the landscape, either geological or anthropogenic • subterranean karstic terrain and faults • craters, gorges, ranges, caves, massifs, escarpments, plateaus • monuments • tourism related to landforms	• No key environmental landforms.	N/A	N/A	N/A	N/A	N/A	**Potential impacts are not considered significant.** • No key environmental landforms relevant to the Project for the NTEPA 'Landforms' factor. • There will be no modifications to distinctive physical landforms as a result of the Project. All activities will be undertaken in a linear disturbance footprint, following a pre-disturbed pipeline corridor, mostly in the marine environment. Therefore, this factor is not considered relevant to the Project.
LAND	2) Terrestrial environmental quality <u>Objective</u>: Protect the quality and integrity of land and soils so that environmental values are supportedand maintained.	• good quality soils, including chemical, physical, biological and aesthetic qualities thatsupport life • the biological processes that depend on soil quality	Soils within the Darwin Liquefied Natural Gas (DLNG) facility footprint (inclusive of the shore crossing) are typical of the broader soil types on Wickham Point, which comprise (ConocoPhillips, 2019): • Bedrock consists of meta-sediments that have metamorphosed and undergone one major deformation, producing steep dips and resulting in the pervasive north-north-east strike of the strata; and • Burrell Creek Formation that consists of a sequence of phyllite, siltstone, shale, sandstone and conglomerate.	N/A	No	No	No	No	**Potential impacts are not considered significant.** • Direct disturbance to the shoreline at the location of the shore crossing may potentially disturb ecological and hydrological values of the area. However, given the onshore site has previously been disturbed during construction of the DLNG facility, impacts would be minimal. Furthermore, keeping the shore crossing within the existing cleared DLNG footprint avoids impacting an undisturbed site. • Potential for interaction with ASS when trenching within the mangrove muds can lead to water quality effects. Mitigation and management measures in place for

Theme	Environmental factor and objective	Indicative environmental values and sensitivities relevant to each environmental factor	Summary of key environmental values and sensitivities of relevance to the Project	Proponent's answer to screening questions 1-5. If answer is 'yes' referral is required (Yes/ No/ Uncertain or Not Applicable (N/A))					Preliminary evaluation of significance (Nature, scale, context and sensitivity; refer definition provided below table)
				Q1	Q2	Q3	Q4	Q5	
			There are no known areas of contaminated soils within the DLNG facility (ConocoPhillips, 2019), inclusive of the shore crossing. There is potential for Acid Sulfate Soils (ASS) in the mangrove muds in the vicinity of the shore crossing, as experienced during the initial construction of Darwin LNG.						disposal of acidic muds, including an ASS/PASS Management Plan. If identified, ASS material will be kept submerged, alongside the trench within the existing pipeline disturbance footprint. If this is not possible, ASS will be removed and stored onshore within the DLNG boundary and treated with lime to neutralise acidity. This disposal of spoil will not impact landforms as it will be located below the water line. • Removal of temporary groyne material may lead to localised water quality impacts and ASS disturbance considerations.
	3) Terrestrial ecosystems Objective: Protect terrestrial habitats to maintain environmental values including biodiversity, ecological integrity and ecological functioning.	• 'sensitive or significant' vegetation or buffers (as defined in the NT Land ClearingGuidelines) • vegetation that provides an important ecological function • listed threatened species and their habitat (NT and Commonwealth) • listed migratory species and their habitat (Commonwealth) • listed threatened ecological communities (Commonwealth) • locally endemic species or species with restricted habitat • species of social, cultural, livelihood and/or economic significance • species that are data deficient and their status is unknown • protected area or reserve, including Indigenous Protected Area • existing conservation and management activities • introduced species and/or invasive species • integrity of terrestrial ecosystems and the ecological services they provide • biological and functional diversity • provision of refuge • food supply	• Minimal flora species, native vegetation or fauna habitats occur within the existing cleared DLNG footprint. The area of the existing shore crossing, within which the Project will occur, was previously cleared, with no requirement for additional disturbance to mangroves outside the current corridor. • Five fauna habitats are known to occur in the wider Wickham Point area (ConocoPhillips, 2019). • Terrestrial fauna and introduced species described at Wickham Point with potential to occur within the DLNG facility and surrounds: 15 mammal species (including two introduced species), 11 species of reptiles, 90 bird species and various frog species (ConocoPhillips, 2019). • An *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) Protected Matters Search completed for the Project (DAWE, 2021) identified approximately; 13 birds, 10 mammals, one reptile and five migratory terrestrial species with potential to occur within a 5 km buffer of the Project area. • Several threatened fauna species listed under the *Territory Parks and Wildlife Conservation Act 2001* (NT) (TPWC Act) with potential to occur within the DLNG facility and surrounds (ConocoPhillips, 2019). • No protected areas or reserves occur within the vicinity of the DLNG facility (ConocoPhillips, 2019). • No nominated, provisional or declared heritage places located within, or directly adjacent to, the DLNG facility site (ConocoPhillips, 2019).	N/A	No	No	No	No	**Potential impacts are not considered significant.** • Onshore area for the Project has previously been cleared during construction of the DLNG facility (inclusive of the shore crossing) in 2003-2004 and unlikely to support habitat for threatened species. This has been verified by site assessments. • The shore crossing alignment is fully within the existing DLNG footprint and disturbance extents will be clearly demarked to prevent impacts beyond agreed boundaries for the Project. • Potential for increase in dust, noise and light emissions during construction with minimal effect on potential fauna within the area. • A Construction Environmental Management Plan (CEMP) will be developed and include controls for introduced species (weeds), dust, noise and artificial light, etc
WATER	1) Hydrological processes Objective: Protect the hydrological regimes of groundwater and surface water so that environmental values including ecological health, land uses and the welfare and amenity of people are maintained.	• the supply and quantity of water in surface water features including rivers, lakes, wetlands, swamps, creeks, billabongs, intermittent streams, floodplains, mangroves and drainage lines • the supply and quantity of water in groundwater features including aquifers, aquitards and water tables • declared beneficial uses • present and future uses, and users of water	• Groundwater monitoring onsite at the DLNG facility and an offsite reference bore, show standing water levels fluctuating between approximately 0.5 m and 4.0 m (ConocoPhillips, 2019). • Higher groundwater water table observed during the wet season compared to the dry season (ConocoPhillips, 2019). • No permanent freshwater habitats on Wickham Point (ConocoPhillips, 2019). • Several small creek lines flow from upland areas of Wickham Point to the harbour during the wet season (ConocoPhillips, 2019). • The waters of Darwin Harbour are declared to	N/A	No	No	No	No	**Potential impacts are not considered significant.** • Onshore area for the Project has previously been disturbed during construction of the DLNG facility. • No permanent surface water features within the DLNG site and surrounds (except on-site water storage, sediment ponds). • There will be no modifications to hydrological processes as a result of the Project. All activities will be undertaken in a linear disturbance footprint, mostly in the marine environment with limited scale and extent. Trenches will be backfilled after construction. There will be no significant changes

Theme	Environmental factor and objective	Indicative environmental values and sensitivities relevant to each environmental factor	Summary of key environmental values and sensitivities of relevance to the Project	Proponent's answer to screening questions 1-5. If answer is 'yes' referral is required (Yes/ No/ Uncertain or Not Applicable (N/A))					Preliminary evaluation of significance (Nature, scale, context and sensitivity; refer definition provided below table)
				Q1	Q2	Q3	Q4	Q5	
		• current or potential water supplies, including regional scale aquifers • culturally important water features or other features affected by water level	have beneficial uses for the protection of aquatic ecosystems, recreational water quality and aesthetics, under the NT *Water Act*.						to the surfaces and therefore no risk of significantly altering the existing hydrological regime. The likelihood of potential impacts to hydrological regimes of groundwater and surface water in the area is considered to be low and insignificant.
	2) Inland water environmental quality <u>Objective</u>: Protect the quality of groundwater and surface water so that environmental values including ecological health, land uses and the welfare and amenity of people are maintained.	• the quality of water in surface water features including rivers, lakes, wetlands, swamps,creeks, billabongs, intermittent streams, floodplains, mangroves and drainage lines • the quality of water in groundwater features including aquifers and water tables • declared beneficial uses • present and future uses and users of water • current or potential water supplies, including regional scale aquifers • potability / drinkability • culturally important water features	• Groundwater pH predominantly acidic (e.g. between 3.8 to 6.7 (ConocoPhillips, 2019). • Groundwater generally low conductivity (ConocoPhillips, 2019). • Heavy metals elevated in groundwater, reflective of the geology of the area (ConocoPhillips, 2019). • No permanent freshwater habitats on Wickham Point (ConocoPhillips, 2019). • Several small creek lines flow only during the wet season from upland areas of Wickham Point to the harbour (ConocoPhillips, 2019). • The natural waterways within the Darwin Harbour region are declared as a beneficial use area.	N/A	No	No	No	No	**Potential impacts are not considered significant.** • Onshore area for the Project has previously been disturbed during construction of the DLNG facility. • No permanent surface water features within the DLNG site and surrounds which includes the Project Area. • An ASS management plan will be implemented to prevent water quality impacts. • There will be no impact to inland water environmental quality as a result of the Project. All activities will be undertaken in a linear disturbance footprint, mostly in the marine environment with limited scale and extent. The likelihood of potential impacts to inland water bodies of surface water in the area is considered to be low and insignificant.
	3) Aquatic ecosystems <u>Objective</u>: Protect aquatic habitats to maintain environmental values including biodiversity, ecological integrity and ecological functioning.	• threatened species • the health of the biota in inland waterways • the habitats that support the lifecycle of aquatic biota • groundwater dependent ecosystems • Ramsar wetlands • species of social, cultural, livelihood and/or economic significance • integrity of aquatic ecosystems and the ecological services they provide • biological and functional diversity • provision of refuge	• No inland aquatic habitats (i.e. lakes, wetlands, creeks) present within the existing DLNG facility and surrounds. • No groundwater dependent ecosystems present. • No Ramsar wetlands occur within the vicinity of the DLNG facility.	N/A	No	No	No	No	**Potential impacts are not considered significant.** • Onshore area for the Project has previously been cleared during construction of the DLNG facility and there are no inland aquatic environments within the boundaries of the DLNG facility. • There are no freshwater aquatic ecosystems (i.e. lakes, rivers) located within or near the Project Area. The mitigation measures would be the same for marine environment quality. This factor is not considered relevant to the Project.

Theme	Environmental factor and objective	Indicative environmental values and sensitivities relevant to each environmental factor	Summary of key environmental values and sensitivities of relevance to the Project	Proponent's answer to screening questions 1-5. If answer is 'yes' referral is required (Yes/ No/ Uncertain or Not Applicable (N/A))					Preliminary evaluation of significance (Nature, scale, context and sensitivity; refer definition provided below table)
				Q1	Q2	Q3	Q4	Q5	
SEA	1) Coastal processes <u>Objective</u>: Protect the geophysicaland hydrological processes that shape coastal morphology so thatthe environmental values of the coast are maintained.	• processes that support marine ecosystems (see Marine Ecosystems Factor below) such as coral reefs, mangroves, salt marshes, seagrass meadows and sponge gardens • primary productivity • nutrient cycling • carbon storage • climate regulation • conservation significant low lying areas including tidal creeks, deltas and river mouths • storm surge protection • unique coastal landforms • cultural and aesthetic values • active or passive recreation	• Nearshore coastal ecosystems in the Darwin Harbour are under the influence of a predominantly macrotidal regime supporting mangroves, intertidal flats and rock platforms.	N/A	Yes	Yes	No	No	**Potential impacts are not considered significant.** • The installation of the pipeline will disturb areas of seabed in Darwin Harbour, the spoil disposal ground, borrow area and the shore crossing during pre-lay works (e.g. trenching, construction of the temporary groyne, spoil disposal and span rectification works) and post-lay works (e.g., trench backfill/rock dump and removal of sand from borrow grounds). • Any spoil removed will be deposited where it will not affect coastal processes. • The Project will not result in a significant change to the existing activities/uses within Darwin Harbour, including coastal processes • Increased sedimentation may result during pipeline trenching/excavation activities which may temporarily influence coastal processes. However, given coastal processes within Darwin Harbour are subject to large tides and strong seasonal influences (wet-season run-off, storms and cyclones) it is considered unlikely that the Project will influence on coastal processes would have significant impact. • Potential impacts will be localised and temporary. Any change to the shore crossing area for the pipeline shore pull activity, will be temporary during pipeline installation and the site will be remediated.
	2) Marine Environmental Quality <u>Objective</u>: Protect the quality and productivity of water, sediment and biota so that environmental valuesare maintained.	• quality of the water, sediment and biota • ecosystem health condition • physical parameters that support fishing and aquaculture • physical parameters that support recreation and aesthetics • industrial water supply • cultural and spiritual values	• Water quality within Darwin Harbour is generally in excellent condition with seasonal and tidal scales providing temporal variation (ConocoPhillips, 2019). • Spatial gradient observed in Darwin Harbour's water quality, with turbidity in the upper reaches higher than that of the outer harbour (ConocoPhillips, 2019). • Large tidal movements and strong currents in Darwin naturally generate high turbidity, particularly during spring tides (ConocoPhillips, 2019). • Water quality parameters remain consistent in the offshore environment (ConocoPhillips, 2020). • Water quality in the Northwest Shelf Transition Province is characterised by low salinity, oligotrophic (low nutrients), influenced by the Indonesian throughflow (ConocoPhillips, 2020).	N/A	Yes	Yes	No	Yes	**Potential for significant impacts** • The Project may lead to temporary and localised increases in turbidity from disturbed sediments during trenching and pipelay activities. Any increases in suspended sediments from pipelay activities and/or sedimentation for both intertidal and subtidal habitats, would be localised and temporary in nature, with the water column rapidly returning to its natural conditions when trenching stops.. Studies of the larger INPEX dredging program in Darwin Harbour demonstrated no measurable environmental impact to seagrass or coral habitats at monitoring sites with the exception of corals at South Shell Island (noting the Project extents to not intersect with this location). INPEX stated that episodic events (tropical storms and cyclones) caused naturally elevated turbidity at much higher intensities over large areas than anything observed from dredging excess alone. Given the pre-lay activities/trenching and level of sediment removal required for the Project is much less than what was required for the INPEX Ichthys Project, it is considered unlikely that the Project would significantly impact on benthic habitats, including seagrass and coral habitats. • Turbidity within the harbour is a natural occurrence as a result of large tidal movements and strong currents, therefore impacts on water quality the

Theme	Environmental factor and objective	Indicative environmental values and sensitivities relevant to each environmental factor	Summary of key environmental values and sensitivities of relevance to the Project	Proponent's answer to screening questions 1-5. If answer is 'yes' referral is required (Yes/ No/ Uncertain or Not Applicable (N/A))					Preliminary evaluation of significance (Nature, scale, context and sensitivity; refer definition provided below table)
				Q1	Q2	Q3	Q4	Q5	
									surrounding marine environment are expected to be negligible. • Construction vessels involved in pipelay activities within the shallower waters of Darwin harbour, will require anchoring to the seabed which may result in direct impact to benthic habitats in these locations. • Increase in vessel traffic, including pipelay vessels and construction vessels resulting in increased discharges from vessels (e.g. ballast water, cooling water, sewage etc). Impacts from planned/routine discharges would be highly localised and only result in temporary decreases in water quality within the harbour. • Unplanned discharges/spills from Project vessels (e.g. refuelling etc) may result in short-term decrease in water quality. However, natural tidal flows and regimes within the nearshore environment will allow these discharges to dissipate effectively. • The Project is unlikely to result in a significant long-term change to the existing physical parameters within Darwin Harbour and therefore are unlikely to affect recreation and aesthetic values in the long-term. Temporary amenity issues may be experienced during the construction phase with the increase in vessel traffic and construction equipment within the harbour. • Gas release during operations (e.g. from a pipeline rupture incident) is considered a highly unlikely event and the implementation of a precautionary zone around the pipeline location will minimise the risk of this occurring. Precautionary zones have been implemented for other pipelines within the area and are considered to be successful in minimising impacts from a rupture incident during operations. • A Construction Environmental Management Plan (CEMP) will be developed and include controls for noise and artificial light. • A Trench, Spoil Disposal Management and Monitoring Plan (TSDMMP) will be developed to include controls for trenching and related activities based on water quality monitoring data. • An ASSMP will be developed for the shore crossing activities. • A Waste Discharge Licence (WDL) will be applied for to manage planned discharges to the spoil disposal ground.

	3) Marine ecosystems
	
	Objective: Protect marine habitats to maintain environmental
		• conservation significant marine and coastal fauna and critical habitat such as nesting, breeding or foraging habitat
		• conservation significant marine and coastal benthos, flora and vegetation (seagrass meadows, sponge gardens, coral reefs,
			Conservation significant fauna known to occur within the Project Area include:
			• Marine turtles:
			  ◦ Flatback Turtle – Biologically Important Area (BIA) internesting and habitats critical to the survival of the species intersect the Project Area
			  ◦ Olive Ridley Turtle – BIA internesting and
				N/A	Yes	Yes	No	Yes	**Potential for significant impacts**
									
									• Trenching activities may impact on marine animals such as turtles, inshore dolphins and dugongs, by temporarily altering their behaviour and avoiding the area during works.
									• Construction activities such as trenching may temporarily cause avoidance of turtles, dolphins and fish known to

Theme	Environmental factor and objective	Indicative environmental values and sensitivities relevant to each environmental factor	Summary of key environmental values and sensitivities of relevance to the Project	Proponent's answer to screening questions 1-5. If answer is 'yes' referral is required (Yes/ No/ Uncertain or Not Applicable (N/A))					Preliminary evaluation of significance (Nature, scale, context and sensitivity; refer definition provided below table)
				Q1	Q2	Q3	Q4	Q5	

	values including biodiversity, ecological integrity and ecological functioning.	mangrove communities and salt marshes)
		• groups of species (species richness and assemblages of species)
		• ecological functions and processes
		• species of social, cultural, livelihood and/or economic significance.
		• integrity of marine ecosystems and the ecological services they supply
		• biological diversity
		• functional diversity
		• provision of refuge
		• food supply
			habitats critical to the survival of the species occur nearby to the Project Area around the Tiwi Islands.
			• Dugongs
			  ◦ There are no Dugong BIAs within or nearby to the Project however, Dugongs are known to frequent inshore waters along the NT coast.
			  ◦ Dugongs are also present in Darwin Harbour (e.g. around Weed Reef). During the Ichthys EIS assessment process, there was concern from stakeholders around impacts that underwater noise and trenching could have on Dugongs at Casuarina Beach and Fannie Bay.
			• Inshore dolphins:
			  ◦ The Project Area intersects BIA's for the Australian Snubfin Dolphin, Indo-Pacific Humpback Dolphin and the Indo-Pacific/Spotted Bottlenose Dolphin, known to undergo breeding, calving and/or foraging within Darwin Harbour.
			• Shorebirds and seabirds:
			  ◦ 13 threatened migratory bird species have the potential to occur within the Project Area.
			• The INPEX Ichthys Project identified no critical habitat or aggregation areas for fish within the offshore area
			• Mangrove habitats utilised for fish breeding are extensive and widespread throughout Darwin Harbour.
			• Darwin Harbour is recognised as a NT Site of Conservation Significance supporting a range of estuarine, freshwater and terrestrial environments of ecological values, including extensive areas of intertidal mudflats rock platforms and a diverse area of mangroves. The rocky shore communities support a range of marine flora and fauna, including oysters, limpets, barnacles, chitons, sponges, crustaceans, hard and soft corals and various algae/macroalgae species (INPEX, 2010).
			• The Port Darwin wetlands (NT029 Port Darwin) are listed as a Nationally Important Wetland under the Directory of Important Wetlands in Australia, located on the inner shores of Darwin Harbour.
			• The Project area intersects the Charles Point Reef Protection Area (RPA) and is relatively close proximity to the Lorna Shoal RPA (approximately 9 km to the east). The protection of these areas is to prevent over-fishing of golden snapper, black jewfish and other vulnerable reef species.
			• Benthic habitat within Darwin Harbour predominantly comprises of macroalgae and filter feeders.
			• Use of mud whelks for indigenous food.
									occur in the area with potential impacts on behaviour.
									• Underwater noise and light emissions generally have the potential to impact marine fauna, given Project vessels will not add significantly to the existing vessel traffic, vessel-based activities, or lighting in Darwin Harbour and beyond, impacts on marine ecosystems beyond temporary behavioural changes (e.g. avoidance of Project activities) are unlikely.
									• Whale migration tends to occur further offshore within Commonwealth waters and is therefore unlikely to be adversely impacted by the Project.
									• Light emissions generated by vessels and other construction activities may present a potential risk to marine fauna (i.e. birds, turtles, sharks/rays and other fish) causing a temporary change in movement patterns and/or behaviour.
									• Potential for vessel collision with marine fauna such as turtles, inshore dolphins and dugongs, however, given the large number of vessels already utilising Darwin Harbour regularly, the increase in vessel traffic from the Project is considered unlikely to result in a greater risk of vessel collision with marine fauna.
									• Fish may be attracted to areas disturbed by trenching to feed upon invertebrates liberated from the seafloor sediments and there may be an increase in feeding and predation. It is unlikely that mortality would occur from physical clogging of their gills by turbid plumes as this type of impact is generally only evident with very high suspended sediment concentrations (e.g. 400 mg/L), which would be very rare for the Project, as per the Ichthys assessment.
									• There is also potential for fish deaths caused by water acidity from localised impacts of acid sulfate leachates in the marine environment. Areas of potential ASS should be monitored prior to and during trenching activities to avoid water acidity impacts.
									• Pre-lay trenching within shallower waters in Darwin Harbour may result in displacement and smothering of benthic organisms and habitats during pipelay activities. Although the Project follows the existing Bayu-Undan to Darwin pipeline and avoids sensitive benthic habitats, further assessment should be undertaken to qualify the extent of impacts once the construction methodology is confirmed.
									• Areas where pipeline is to be laid on the seabed will result in localised disturbance of a narrow corridor.
									• Pipeline shore crossing to be trenched and backfilled with rock and excavated material up to ground level requiring removal of a small area of mudflat and potential mangrove habitat. A vegetation survey of the shore crossing disturbance area confirmed the presence of only one species of mangrove in proximity to the proposed alignment, *Sonneratia alba*, of which there were only a handful of individuals (e.g. less than 5 plants within 20 m either side). This species of mangrove (*S. alba)* is a common taxon that is well represented and characterised as part of the mangrove monitoring programme at DLNG. It is considered unlikely that the small amount of habitat

Theme	Environmental factor and objective	Indicative environmental values and sensitivities relevant to each environmental factor	Summary of key environmental values and sensitivities of relevance to the Project	Proponent's answer to screening questions 1-5. If answer is 'yes' referral is required (Yes/ No/ Uncertain or Not Applicable (N/A))					Preliminary evaluation of significance (Nature, scale, context and sensitivity; refer definition provided below table)
				Q1	Q2	Q3	Q4	Q5	
									disturbed would result in long-term effects to the ecological function of the mangrove community. • Trenching in the nearshore environment of Darwin Harbour will result in disturbance to the Port Darwin Wetlands. However, as described above, a vegetation survey of the shore crossing location has confirmed that the vegetation within proximity to the proposed alignment are typically of low-value (excepting *S. alba*), and well represented in the area. Where mangrove species exist, these are in very low numbers within the corridor, and any disturbance to these individuals would be limited in extent and determined to not have any significant impact to the broader environmental values at a community or population level. • Spoil disposal ground for trenched material located north of Darwin Harbour and opposite the Ichthys spoil ground. • Rock armoured pipeline will provide artificial reef habitat. • Planned and unplanned discharges associated with construction activities may impact on marine ecosystems.
AIR	1) Air quality <u>Objective</u>: Protect air quality and minimise emissions and their impactso that environmental values are maintained.	• the chemical, physical and biological characteristics of quality air • the biological processes that depend on the air quality	• There are no permanent sources of air pollution in the offshore environment and air quality is likely to be excellent. • The nearshore environment within Darwin Harbour is within the Darwin regional airshed, with contributing influences from vehicles, industrial point sources, shipping and biogenic sources. In particular, regional air quality is influenced seasonally from bushfires.	N/A	No	No	No	No	**Potential impacts are not considered significant.** • Air emissions from vessels (e.g. engines and generators) in the offshore environment are likely to dissipate rapidly, with no measurable impact on the ambient offshore air quality. • Air emissions from vessels in the nearshore environment will be localised and temporary (during construction) • Given the nature of Darwin Harbour as an extensive shipping channel/Port, it is expected that Wickham Point, and the areas surrounding Darwin Port, would experience changes in the local air quality influenced by the number of vessels transiting through the area. The Project will result in a temporary increase in shipping traffic, however appropriate engagement and planning with the relevant authorities will avoid significant impacts. • Generation of dust associated with construction of the shore crossing, however, given the site has already been cleared, impacts are likely to be limited to trenching works. Appropriate dust control measures are considered to be effective in mitigating potential impacts. • Potential for release of air emissions from commissioning activities (e.g. dry natural gas release from pipeline). • With the application of appropriate mitigation measures, the Project impacts and risks are manageable such that environmental values are supported and maintained.
	2) Atmospheric processes <u>Objective</u>: Minimise greenhouse gas emissions so as to	• a contribution to the NT's greenhouse gas emissions • adaptation to a changing climate • capacity of communities and country to respond or adapt to climate change	• Emissions from the Project will be minimal in a local scale greenhouse emissions context.	N/A	No	No	No	No	**Potential impacts are not considered significant.** • Increase in greenhouse gas emissions associated with Project vessels are likely to be minimal, however given the pipeline installation activities may take up to 15 months within NT waters, this may contribute to a cumulative increase in GHG

Theme	Environmental factor and objective	Indicative environmental values and sensitivities relevant to each environmental factor	Summary of key environmental values and sensitivities of relevance to the Project	Proponent's answer to screening questions 1-5. If answer is 'yes' referral is required (Yes/ No/ Uncertain or Not Applicable (N/A))					Preliminary evaluation of significance (Nature, scale, context and sensitivity; refer definition provided below table)
				Q1	Q2	Q3	Q4	Q5	
	contribute to the NT Government's goal of achieving net zero greenhouse gas emissions by 2050.								emissions to be considered. • Noting that NT regulators are focusing on industry within Darwin Harbour and associated GHG emissions. • GHG emissions associated with the project will be managed under existing legislative regimes and environmental approvals (e.g., DLNG life extension approvals). • With the application of appropriate mitigation measures, the Project impacts and risks are manageable such that environmental values are supported and maintained.

PEOPLE	1) Community and economy
	
	<u>Objective</u>: Enhance communities and the economy for the welfare, amenity and benefit of current and future generations of Territorians.
		• dwellings, homelands, communities, towns and suburbs where people live
		• liveable environment
		  ○ good amenity – air quality, noise, aesthetics
		  ○ access to natural resources including bush food
		  ○ recreational use of the natural or built environment (e.g. fishing, cycling, sports, picnics)
		  ○ access to social infrastructure and services including transport and logistics
		• Healthy lifestyles
		  ○ sense of wellbeing
		  ○ good mental health
		  ○ community aspirations
		• Financial security
		  ○ affordable access to food, water, electricity, transport and communication networks
		  ○ livelihoods
		• participation in jobs, businesses and education
		• existing industries such as agriculture, pastoralism, tourism, fisheries
		• vulnerable sectors of the community
		• connections to culture and community (that are not explicitly protected under cultureand heritage legislation addressed in the Culture and heritage factor)
		  ○ Aboriginal rights and interests, including right of access
		  ○ cultural practices
		  ○ sense of belonging, inclusion, connectedness and cohesion
		  ○ healthy social relationships
			• One Commonwealth fisheries overlaps the location of the Project namely, Northern Prawn Fishery.
			• Three NT fisheries overlap the Project Area namely, Spanish Mackerel, Coastal Line Fishery and Demersal Fishery.
			• Darwin Harbour is utilised for commercial shipping, recreational boating and fishing, tourism and naval activities (ConocoPhillips, 2019).
				N/A	No	No	No	No	**Potential impacts are not considered significant.**
									
									• The Project will require the provision of local goods and services throughout the construction period resulting in employment opportunities and economic benefits for the NT.
									• The Project will not propose a significant change to the existing activities/uses within the offshore and nearshore marine environments (including in Darwin Harbour) and are unlikely to result in a long-term adverse impact on the local community and economy.
									• Temporary increase in vessels during construction activities (i.e. pipelay vessels, rock dump vessels, supply vessels and general construction vessels), including anchored vessels within shallow waters within the harbour and dynamically positioned vessels for deeper waters.
									• The Project may require temporary access restriction to fishing sites during construction (i.e. around vessels and pipeline), however these activities will be localised and will not prohibit fishing activities nearby. No different to previous pipeline construction projects in Darwin Harbour.
									• A precautionary zone may be required around the pipeline within the Northern Prawn Fishery to avoid damage to fishing equipment and the pipeline. This area would be small in relation to the area available to the fishery and unlikely to result in a significant impact, especially given the DPD pipeline is only ~100 m from the existing BU-Darwin pipeline
									• Trenching may cause increased sedimentation within the harbour waters, adversely affecting the water quality and productivity of fishing activities. These impacts would be temporary and localised to a narrow corridor surrounding the pipeline.
									• Potential for increased fishing opportunity in the long-term through provision of artificial reef.
									• Increased pressures on local goods and services to accommodate construction workforce, however this would be temporary and ongoing consultation with the local community will assist in managing potential impacts.
									• Temporary increase in traffic, including heavy

Theme	Environmental factor and objective	Indicative environmental values and sensitivities relevant to each environmental factor	Summary of key environmental values and sensitivities of relevance to the Project	Proponent's answer to screening questions 1-5. If answer is 'yes' referral is required (Yes/ No/ Uncertain or Not Applicable (N/A))					Preliminary evaluation of significance (Nature, scale, context and sensitivity; refer definition provided below table)
				Q1	Q2	Q3	Q4	Q5	
									haulage for machinery and equipment, sourcing of rock from quarry for rock-placement Rock quarrying, transport and ship loading to be managed by third parties using approved facilities and in accordance with local road transport regulations.
	2) Culture and heritage <u>Objective</u>: Protect sacred sites, culture and heritage.	• sacred sites • historic heritage and places • world heritage	• [redacted] • [redacted] • Wickham Point and other areas surrounding Darwin Harbour have significant European heritage values. • [redacted] A number of shipwrecks considered to be associated with World War II are located within Darwin Harbour. • One shipwreck nearby to the Project area that is protected under the Commonwealth *Underwater Cultural Heritage Act 2018* namely, the Japanese submarine I-124, sunk in 1942.	N/A	No	No	No	No	**Potential impacts are not considered significant.** • The onshore DLNG facility was surveyed prior to the construction of the facility to identify heritage values. There are no Aboriginal sites of significance within the shore crossing. • The location of shipwrecks within Darwin Harbour and surrounds is well understood. The Project may result in temporary access restrictions to diving sites during construction. However, these are short-term activities and should only temporarily affect recreational diving. • The potential for long term adverse effects to shipwrecks is considered unlikely, given the route alignment is to avoid known shipwrecks. • Disturbance of UXO's is unlikely as specialist site surveys have been undertaken.

Theme	Environmental factor and objective	Indicative environmental values and sensitivities relevant to each environmental factor	Summary of key environmental values and sensitivities of relevance to the Project	Proponent's answer to screening questions 1-5. If answer is 'yes' referral is required (Yes/ No/ Uncertain or Not Applicable (N/A))					Preliminary evaluation of significance (Nature, scale, context and sensitivity; refer definition provided below table)
				Q1	Q2	Q3	Q4	Q5	
	3) Human health <u>Objective</u>: Protect the health of the Northern Territory population.	• drinking water • recreational water • air quality • bush tucker • radiological limits • biting insects	• The existing DLNG facility is not within a Public Drinking Water Area. • Fishing tourism is important to the NT's economy and there are several fishing clubs who utilise Darwin Harbour (ConocoPhillips, 2019). • The nearshore environment within Darwin Harbour experiences extensive shipping traffic. • Biting insects are prevalent on a seasonal and diurnal basis in and around the mangrove fringe of Wickham Point and surrounds.	N/A	No	No	No	No	**Potential impacts are not considered significant.** • Given the onshore location of the Project being within an industrialised area, it is considered unlikely that significant impacts would occur to human health from this component of the Project. • Darwin Harbour is utilised as a fishing area but given the extensive use of the harbour for commercial shipping activities, the Project works are not expected to cause a significant long-term change to the existing activities/uses of the harbour and are therefore unlikely to impact on human health. • The activities arising from the Project are within the existing cleared DLNG pipeline corridor. Impacts are deemed to be insignificant, and not expected to give rise to human health effects, and further assessment is not required. • Amenity impacts arising from air quality (dust), noise and light are addressed in Air Quality, demonstrated to be localised and temporary in nature.

1.3 Definition of 'Significant Impact'

The Northern Territory *Environment Protection Act 2019* (EP Act) defines a significant impact as:

"A significant impact of an action is an impact of major consequence having regard to:
(a) the context and intensity of the impact; and
(b) the sensitivity, value and quality of the environment impacted on and the duration, magnitude and geographic extent of the impact".

The NT EPA guidance on referral of a proposal (NTEPA, 2021a) outlines how the NT EPA determines that environmental impact assessment of a proposal is not required. The NT EPA will consider the proposal in terms of its potential for significant environmental impacts. In its consideration, the NT EPA will examine:

- context and intensity of the impact
- duration, magnitude and geographic extent of the impact and
- sensitivity, value and quality of the environment impacted on.

Environmental impact assessment is unlikely to be required where:

- the type of proposal is not considered hazardous in nature
- environmental impacts from activities associated with a proposal are readily understood
- the potential impacts are limited in extent and duration
- environmental values and sensitivities are not present or are unlikely to be significantly impacted by proposed activities
- impact mitigation is readily available and proven to be effective in limiting significant impacts to the environment, and
- the referral demonstrates that relevant stakeholders have been identified and engaged, and documents the outcomes of the engagement, in accordance with the NT EPA's guidance on stakeholder engagement and consultation.

1.4 References

ConocoPhillips, 2019. *Darwin LNG Transition Work Program Notice of Intent*. ConocoPhillips. Perth, Western Australia.

ConocoPhillips, 2020. *Barossa Gas Export Pipeline Environment Plan*. ConocoPhillips. Perth, Western Australia.

Department of Agriculture, Water and Environment (DAWE), 2021. *Protected Matters Search Tool (PMST) Report*. Available from: Protected Matters Search Tool: Interactive Map (environment.gov.au) (accessed 19/05/2021).

Department of the Environment and Energy (DoEE), 2017. *Recovery Plan for Marine Turtles in Australia*. Australian Government, Canberra, Australian Capital Territory.

Northern Territory Environment Protection Authority (NTEPA), 2021a. *Referring a Proposal to the NT EPA: Environmental impact assessment, Guidance for proponents (version 1.0)*. Darwin, Northern Territory, Australia.

Northern Territory Environment Protection Authority (NTEPA), 2021b. *NT EPA Environmental Factors and Objectives: Environmental impact assessment General Technical Guidance (version 2.0)*. Darwin, Northern Territory, Australia.

Appendix G – Assessment of EPA Factors - Not Significant Factors and Objectives

Assessment of EPA Factors (Considered Not Significant) and Objectives

Element	Description
Terrestrial Environmental Quality	
NT EPA Factor and Objective	+ Protect the quality and integrity of land and soils so that environmental values are supported and maintained.
Policy and guidance	+ Land Clearing Guideline (DENR, 2019); + Preparation of an Environmental Management Plan (NT EPA, 2015); + Environmental Impact Assessment and Environmental Approval in the Northern Territory: Environmental Impact Assessment Guidance (NT EPA, 2021b); + Identification and Investigation of Acid Sulphate Soils (ASS) and Acidic Landscapes (DER, 2015a); + Treatment and Management of Soils and Water in Acid Sulphate Soil Landscapes (DER, 2015b); + DLNG Exceptional Development Permit; + Waste Management and Pollution Control Act 1998 (NT); + Water Act 1992 (NT); + Soil Conservation and Land Utilisation Act (NT); and + DLNG Environment Protection Licence conditions.
Potential Impacts	<u>Construction</u> + Erosion and sedimentation; – Pre-lay works (including trenching of the shore crossing and onshore pipeline area) and shore pull activities, will create temporary disturbance to land and soils increasing the risk of soil erosion and sedimentation of downstream environments such as the nearby mangrove community by wind / surface water runoff. + ASS; – Pre-lay works including trenching (particularly at the shore crossing location) and disturbance by machinery and rock placement in the intertidal zone, has the potential to disturb Acid Sulphate Soils (ASS) and/or Potential Acid Sulphate Soils (PASS) within the mangrove muds. If acid Sulphate soil is exposed and oxidised, it may cause acid leachate to form leading to mobilisation of heavy metals and run-off of contamination into nearby soils. URS conducted an ASS Investigation for the DLNG Project in 2002 concluding the presence of ASS material within the mangrove muds that underlay tidal flats and mangrove communities along the shoreline of Wickham Point (Phillips Petroleum Company, 2002). + Rock placement; – Rock will be used to construct a temporary groyne. When removed, there is potential for contamination of soils from marine sediments at the final disposal / re-use location. + Chemical spills; – Onshore construction including, shore crossing and shore-pull activities, may result in minor hydrocarbon and chemical spills to land. It is expected that potential impacts can be managed through the implementation of standard management measures including use of spill kits and spill response equipment. <u>Operation</u> + No impact from disturbance or release to land or soils is expected during the operation phase. The risk of soil erosion and sedimentation is low. The risk from ASS during the operational phase of the Project is considered to be negligible, as further exposure of ASS is not expected to occur.
Environmental Management and Mitigation	+ Erosion and sedimentation; – Disturbance from pre-lay works and shore pull activities will be within the existing DLNG facility disturbance envelope and will be temporary, relatively localised and linear in nature. It is considered that impacts can be managed through the application of standard management measures, including the environmental management plans committed to by Santos. – A Construction Environmental Management Plan (CEMP) will be developed including measures for erosion and sediment control, spill and waste (including materials used for temporary groyne construction) management. + ASS; – A geotechnical survey will be undertaken prior to construction and include assessment of ASS to the depth of disturbance. – A specific ASS Management Plan will be developed and implemented, including contingency measures such as: 1. if identified, ASS material will be kept submerged, alongside the trench within the existing pipeline disturbance footprint. If this is not possible, ASS will be removed and stored onshore within the DLNG boundary and treated with lime.

Element	Description
	2. ASS material may be used as backfill after treatment onsite with lime. If it is not geotechnically suitable for re-use, it will be removed from site for other re-use or disposal; or disposed of offshore at the spoil disposal ground. + Rock Placement; – If material from the temporary groyne cannot be re-used within the Project boundary, off-site disposal will require consideration and management of impacts from marine sediments. + Chemical Spills; – Spill kits and spill response equipment (sorbents, booms, skimmers, clean-up equipment etc.) to be maintained during construction to enable a timely response to limit exposure area and period. – Hazardous chemicals to be stored in bunded areas, which shall be to be frequently inspected and maintained.
Potential Cumulative Impact Summary	+ Erosion and sedimentation; – Cumulative impacts are not expected. + ASS; – Cumulative impacts are not expected. + Rock Placement; – Cumulative impacts are not expected. + Chemical Spills; – Cumulative impacts are not expected.
Conclusions and Forward Management	+ The Project has the potential to affect soil or land quality during the construction period, though impacts will be small, temporary, localised and linear in nature. + Disturbance and trenching onshore will be within the existing DLNG facility disturbance area. Impacts will be managed through the application of mitigation measures and monitoring. + Further detailed investigations (in particular the potential for interaction with ASS/PASS) prior to disturbance will be undertaken to support the development of site-specific management plans. + It is concluded that impacts on Terrestrial Environmental Quality are manageable, such that the NT EPA objective for this factor is able to be met with a high degree of certainty.
Terrestrial Ecosystems	
NT EPA Factor and Objective	+ Protect the NT's flora and fauna so that environmental values including biological diversity, ecological integrity ecological functioning are supported and maintained.
Policy and guidance	+ Guidelines for Assessment of Impacts on Terrestrial Biodiversity (NT EPA 2013a); + NT EPA Environmental Factors and objectives: Environmental impact assessment general technical guidance (NT EPA 2021a); + Matters of National Environmental Significance, Significant impact guideline 1.1 (DoE 2013); + Land clearing guidelines (DEPWS 2021); + Weeds Management Act 2001 (NT); + Waste Management and Pollution Control Act 1998 (NT); + Water Act 1992 (NT); + Energy Pipelines Act 1981 (NT); and + Light Pollution: Effects of Wildlife (DAWE, 2021).
Assessment of Potential Impacts	<u>Construction</u> + Native Flora and Fauna; – Pre-lay works (including trenching of the shore crossing and onshore pipeline area) and shore pull activities, may result in the minor direct loss of flora and/or vegetation re-growth (including fauna habitat). Indirect disturbance or degradation to surrounding flora and vegetation from erosion, dust, disturbance of ASS and chemical/hydrocarbon spills may also occur. Impacts are expected to be low and insignificant given the pre-existing context of the DLNG operational facility at Wickham Point. – The onshore portion of the Project will be located within the existing shoreline crossing and corridor that connects into Darwin LNG, which was subject to prior assessment and approval within the existing DLNG disturbance envelope. Therefore, the pre-selection of the proposed pipeline alignment, to co-align with the existing Bayu-Undan to Darwin pipeline corridor, inherently minimises disturbance to terrestrial ecosystems (including flora, vegetation and fauna) and is unlikely to change the existing biological diversity and ecological integrity of terrestrial ecosystems. In addition, no threatened or protected species reside within the onshore disturbance area. A targeted vegetation survey of the shore crossing disturbance area conducted on 17 November 21, confirmed the presence of only one species of mangrove in proximity to the proposed alignment, *Sonneratia alba*, of which there were only a small number of individuals (e.g. less than 5) within 20 m either side of the alignment. *S. alba* is a common taxon that is well represented and characterised as part of the mangrove monitoring programme at DLNG. Other vegetation within the Project area was confirmed to be of low ecological value.

Element	Description
	– Onshore construction including increased personnel presence and vehicle movements during construction, may result in indirect impacts, such as disturbance to fauna resulting in avoidance of the area. Impacts are expected to be low and insignificant given the pre-existing context of the DLNG operational facility at Wickham Point. – Pre-lay works (including trenching of the shore crossing and onshore pipeline area) has the potential to increase the risk of bushfire; however as a major hazard facility fire risk is carefully managed with existing and substantive controls in place to protect the facility. + Introduction or Spread of Invasive Species; – Onshore construction including, shore crossing and shore-pull activities has the potential introduce species (e.g. weeds, ants, cane toads – noting these are present within the DLNG facility and broader surrounds). + Fauna Behaviour Change – elevated noise and light from background conditions, such as from the use of machinery and vehicles have the potential to result in avoidance of the site by animals. Given the location within the existing DLNG disturbance envelope and the surrounding industrialised use of the Port area, local impacts are likely to be negligible and are unlikely to result in detrimental impacts to fauna nearby. Potential impacts will be localised and temporary and will not result in long-term impacts. In addition, Migratory birds do not utilise the onshore disturbance area in any significant way and are expected to avoid the area during construction activities. <u>Operation</u> + No disturbance to terrestrial ecosystems is expected during the operation phase given the location within the existing DLNG disturbance footprint and the existing industries utilising the Darwin Harbour shorelines. Impacts are expected to be low and insignificant given the pre-existing context of the DLNG operational facility at Wickham Point.
Environmental Management and Mitigation	+ Native Flora and Fauna; – A Construction Environmental Management Plan (CEMP) will be developed and include controls for land clearing. – Access restrictions outside Project Area to reduce potential for accidental clearing and unauthorised disturbance. – Vehicle movement and speed restrictions to minimise the potential for dust to adversely impact vegetation and reduces impact to fauna species. – Implementation and compliance with the existing DLNG Emergency Response Plan for bushfires. + Introduction or Spread of Invasive Species; – A Construction Environmental Management Plan (CEMP) will be developed and include controls for introduced species (weeds, insects, fauna). + Fauna Behaviour Change – A Construction Environmental Management Plan (CEMP) will be developed and include controls for dust, noise and artificial light.
Potential Cumulative Impact Summary	+ Native Flora and Fauna; – Given the location of the onshore components of the Project within the existing DLNG disturbance envelope, cumulative impacts to terrestrial ecosystems are not expected. + Introduction or Spread of Invasive Species; – Cumulative impacts are not expected. + Fauna Behaviour Change – As above, cumulative impacts are not expected.
Conclusions and Forward Management	+ The proposed onshore Project activities will result in the direct but minor loss of some flora and vegetation (predominantly re-growth), however this will be minor and inconsequential. There is limited potential for direct disturbance (injury or mortality) to fauna from the onshore activities and/or collisions with vehicles or equipment. Given these activities will be within the existing DLNG facility disturbance area and the application of approved mitigation and management measures, it is concluded that impacts on Terrestrial Ecosystems are manageable, such that the NT EPA objective for this factor is able to be met with a high degree of certainty.
Air Quality	
NT EPA Factor and Objective	+ Protect air quality and minimise emissions and their impact so that environmental values are maintained.
Policy and guidance	+ Environmental Impact Assessment and Environmental Approval in the Northern Territory: Environmental Impact Assessment Guidance (NT EPA, 2021b); + Ambient Air Quality National Environment Protection Measure (NEPM); + NT EPA Draft Guideline Recommended Land Use Separation Distances (NT EPA, 2017); + DLNG Environment Protection Licence conditions; + Noise Guidelines for Development Sites in the Northern Territory (NTEPA 2014); and + Exceptional Development Permit.

Element	Description
Assessment of Potential Impacts	<u>Construction</u> + Air (Dust); – The project activities, as relevant to this factor of Air Quality (dust) have limited potential for off-site effects. The pipeline shore crossing and corridor into DLNG are within the existing industrial area, and there are no residential receptors in proximity to the facility. The nearest major residential populations in proximity to the DLNG facility include Palmerston to the north-east of Middle Arm Peninsula (approximately 10 km by direct line of sight from the DLNG site), and the Darwin central business district (approximately 6 km by direct line of sight from the DLNG site). – Onshore construction activities such as use of machinery and vehicles movements, along with trenching, stockpiling and reinstatement works can result in a minor reduction in local air quality. Exposure to dust/particulate matter is also a potential human health risk dependent on exposure, volumes and the receiver's health. This will be very localised, temporary, and highly unlikely to give rise to off-site effects. – Operation of construction equipment and vehicles will generate exhaust particulates. This will result in a localised reduction of air quality in the immediate area of the source. It is anticipated this will be of negligible impact. + Noise; – The proposed project activities will have limited off-site effects from noise. The shore crossing and corridor into DLNG are within the existing industrial area, and there are no residential receptors in proximity to the facility. The nearest major residential populations in proximity to the DLNG facility include Palmerston to the north-east of Middle Arm Peninsula (approximately 10 km by direct line of sight from the DLNG site), and the Darwin central business district (approximately 6 km by direct line of sight from the DLNG site). – Previous noise modelling studies undertaken at the existing DLNG site (Bechtel, 2001 and ConocoPhillips, 2019), indicated that typical minimum noise levels at commercial/residential areas (e.g. Darwin city, East Arm, Durack, Palmerston) ranged between 34.2 decibels A-weighted (dB (A)) and 41.0 dB (A). The construction activities associated with the Project will be smaller in scale and nature compared to the construction of DLNG and potential noise impacts are unlikely at residential receptors. – Operation of construction equipment and vehicles will generate local noise. This will result in a reduction of amenity in the immediate area of the source. It is anticipated this will be of negligible impact considering the industrial and relatively remote location. + Light; – The proposed project activities will have limited off-site effects from light. The shore crossing and corridor into DLNG are within the existing industrial area, and there are no residential receptors in proximity to the facility. The nearest major residential populations in proximity to the DLNG facility include Palmerston to the north-east of Middle Arm Peninsula (approximately 10 km by direct line of sight from the DLNG facility), and the Darwin central business district (approximately 6 km by direct line of sight from the DLNG site). – It is expected that majority of activities will be undertaken during daylight hours, for safety and logistical reasons. Construction and installation activities during the night will require additional lighting, both on land and over water from vessels. – Onshore construction activities including use of machinery and vehicles emitting artificial light may contribute incrementally to the existing light conditions observable by night, temporarily. Increased lighting could result in temporary disruption to wildlife behaviour or amenity impacts. Given that the area does not provide suitable nesting habitat for turtles, is infrequently used by shorebirds, it is unlikely that any species will be adversely affected by lighting during construction of the pipeline and shore crossing, given the short-term temporary nature. – Continuous lighting is provided at the DLNG facility, Ichthys LNG facility and Darwin Port. Therefore it is considered that any lighting generated during short-term construction of the Project will be comparable with the surrounding nearshore and land uses and activities currently operational in the area, for a significantly shorter duration. <u>Operation</u> + No impact to air, noise or light is anticipated above existing approved levels for DLNG during operations.
Environmental Management and Mitigation	+ A Construction Environmental Management Plan (CEMP) will be developed and include controls for dust, noise and light management.
Potential Cumulative Impact Summary	<u>Air (Dust)</u> + Onshore construction activities such as use of machinery and vehicles movements may result in an incremental reduction in local air quality due to the emission of dust. Given the nature of the activities, and the predominance of other sources (including bushfires on a seasonal basis) that influence local and regional air quality, the contribution of the short-term project activities to cumulative air quality will be negligible. <u>Noise and light</u> + Onshore construction including the presence of machinery and increased personnel may result in an incremental reduction in local amenity. Given the nature of the activities, the contribution of the short-term project activities to cumulative noise and light will be negligible.
Conclusions and Forward Management	+ The nature of the Project activities have limited potential to result in significant off-site effects. The shore crossing and connection into DLNG are within the approved corridor for the existing DLNG facility, with no nearby residential receptors, and the nature of the activities will be short-term, localised and temporary. The application of measures to control air quality and noise and light amenity issues are standard and well-established. The environmental objective for Air Quality is to protect air quality and minimise emissions and their impact so that environmental and amenity values are maintained. With the application of appropriate mitigation measures, it is concluded that the project impacts and risks are manageable such that existing environmental values are supported and maintained.

Element	Description
Atmospheric Processes	
NT EPA Factor and Objective	+ Minimise greenhouse gas (GHG) emissions so as to contribute to the NT Government's aspirational target of achieving net zero greenhouse gas emissions by 2050.
Policy and guidance	+ Environmental Impact Assessment and Environmental Approval in the Northern Territory: Environmental Impact Assessment Guidance (NT EPA, 2021b); + National Greenhouse and Energy Reporting Act 2007 (NGER Act); + National Greenhouse and Energy Reporting Regulations (NGER Regulation) 2008; + National Greenhouse Accounts Factors: 2021 (DISER 2021a); + State and Territory Greenhouse Gas Inventories 2018 (DISER 2020); + Northern Territory Climate Change Response: Towards 2050 (NTG 2020); + Greenhouse Gas Emissions Management for New and Expanding Large Emitters (DEPWS 2021d); + MARPOL Annex VI; and + DLNG Environment Protection Licence conditions.
Assessment of Potential Impacts	Construction + Construction-related greenhouse gas (GHG) emissions will be predominantly associated with vessel, vehicle, equipment and helicopter hydrocarbon (e.g., diesel) combustion. Such emissions will be relatively small, temporary and short in duration (i.e. ~15 months). Santos and its contractors will continue to operate in accordance with respective climate change / carbon reduction polices and strategies in order to meet company emission reduction targets. Operation + This referral is based on the premise that the Project operational phase will not alter GHG emissions beyond those already approved for DLNG. The DPD Project will convey natural gas from Barossa to DLNG facility. The environmental approvals described in Appendix B provide for this supply of natural gas and extended DLNG operations to approximately 2050. The extended DLNG operations will be managed in accordance with the Australian Government Safeguard Mechanism, which places a cap (baseline) on DLNG facility GHG emissions. Given GHG emissions will be regulated as part of the DLNG facility, they are not considered to be a key factor for this referral.
Environmental Management and Mitigation	+ Equipment and machinery will be appropriately maintained to minimise air emissions. + Monitoring and reporting of fuel consumption, and calculated GHG emissions, during Project activities to meet legislative requirements and ESG reporting requirements. + Optimise construction activities and transport logistics to minimise fuel consumption. + Pursuant to MARPOL Annex VI, vessels to maintain a current International Air Pollution Prevention Certificate, as relevant to vessel class, which certifies that measures to prevent air emissions are in place.
Potential Cumulative Impact Summary	+ The GHG emissions relevant to the construction phase of the Project will incrementally contribute to the NT and Australian GHG carbon budget. However, given the short-term nature of construction activities the incremental increase in GHG emissions will be temporary and minor in a domestic and national context.
Conclusions and Forward Management	+ The assessment is based on the premise that the Project represents a duplicate pipeline to convey gas from Barossa to DLNG, to be processed within the existing licenced operational capacity. Project construction activities will be an insignificant GHG contributor to the NT and Australian carbon budget; hence, there will be no significant impact to the NT or Australian environment. As such, the NT EPA objective for this factor is able to be met with a high degree of certainty.
Community and Economy	
NT EPA Factor and Objective	+ Enhance communities and the economy for the welfare, amenity and benefit of current and future generations of Territorians.
Policy and guidance	+ Environmental Impact Assessment and Environmental Approval in the Northern Territory: Environmental Impact Assessment Guidance (NT EPA, 2021b); + Darwin Harbour Regional Management Strategic Framework 2009 – 2013 (draft), DHAC; + Guidelines for the preparation of an economic and social impact assessment (NT EPA 2013); + Marine Act 1981 (NT); + Control of Roads Act 1953 (NT); + Traffic Act 2987 (NT); and + Ports Management Act.

Element	Description
Assessment of Potential Impacts	Construction + Socio-Economic: – Employment and economic opportunities locally, regionally and nationally: the Project may increase employment opportunities within the local community during the construction period. – The Project will not present a significant change to the existing activities/uses within the offshore and nearshore marine environments (including in Darwin Harbour) and is unlikely to result in long-term adverse impacts on the local community and economy. – Increased pressures on local goods and services: from accommodation of construction workforce, however this would be temporary and ongoing consultation with the local community will assist in managing potential impacts. – Direct and indirect impacts to recreational and commercial areas and industries including Darwin Harbour: increase in competition for port resources with other users and visual impact of project-related activities during construction. – Damage to commercial fishing equipment or catch from construction activities, vessel movements or hydrocarbon spill. – Reduction in number and quality of fish species targeted by fishers from hydrocarbon spill: along with temporarily displacing fishers from the area, however displacement would likely be localised and short term. – Reduction in mud crab numbers and quality from increased turbidity: The outcomes of a study for Ichthys concluded that potential impacts to mud crabs were low residual risk with the exception of one impact on migration of adult and juvenile mud crabs which was identified as medium risk (SKM, 2011). Given the extent of dredging associated with the Ichthys project (e.g. 16.9 Mm^3 of dredge spoil) compared to the Project (maximum of 750,000 m^3) potential impacts to mud crabs are expected to be low and insignificant. – Reduced water quality and productivity of fishing activities: Potential impacts will be temporary and localised to a narrow corridor surrounding the pipeline. Trenching and disposal of trench spoil at the spoil disposal ground has potential to create localised and temporary sedimentation effects. Monitoring for Ichthys (INPEX Browse, 2010) demonstrated elevated turbidity attenuated to background levels within 5 km from the source at the spoil disposal ground (adjacent the spoil disposal ground for the Project), and within ~ 8 km of the dredge source in East Arm with dispersion greater during spring tides (stronger currents) and during the dry season. Potential impacts are expected to be low and insignificant. – There may be some temporary exclusions to fishing and recreational zones as the vessels move along the Project pipeline route and some recreational users may be deterred from using parts of Darwin Harbour. The environmental monitoring undertaken as part of the Ichthys project, interviewed recreational fishers to determine the level of impact the projects exclusion zones had on their activities. It was concluded that only small-scale spatial shifts in fishing effort were recorded during dredging surveys, but these were accompanied by slight increases in other areas around Darwin Harbour. Given the Ichthys Project’s dredging campaign was significantly larger than the pipeline trenching proposed for the Project, any impact to access and aesthetics of fishing and recreational areas would be much lower. + Traffic and Access: – There will be a temporary increase in vessels during construction activities (e.g. pipelay vessels, rock placement vessels, supply vessels and general construction vessels), including anchored vessels within shallow waters within the harbour and dynamically positioned vessels for deeper waters. – There is potential for local traffic increase during the construction phase. – Temporary reduction in access to recreational fishing areas during construction (e.g. around vessels and pipeline, and spoil disposal ground), however these activities will be localised and will not prohibit fishing activities nearby. There is potential for increased fishing opportunity in the long-term through provision of artificial reef. – Temporary reduction in access to recreational marine activities owing to reduced visibility in turbid waters. – Temporary reduction in of access to traditional fishing and foraging grounds due to vessel activity or spill. – Temporary disruptions to commercial vessel activities with Darwin Port. Operation + Operational activities are not expected to adversely impact the community or economy. The implementation of pipeline precautionary zones is unlikely to significantly impact recreational and commercial activities, other than the inconvenience of not being able to anchor within the narrow precautionary zone.
Environmental Management and Mitigation	+ Socio-Economic; – A Trench, Spoil Disposal Management and Monitoring Plan (TSDMMP) and Waste Discharge Licence (WDL) will be developed to include controls for trenching and related activities based on water quality monitoring data. – Stakeholder engagement plan to continue through Project planning and execution. – Dedicated stakeholder engagement liaison. + Traffic and Access; – Standard maritime communications equipment, navigation lights and markers on Project vessels. – Standard maritime notices will be issued to other marine users as required. – Implement a precautionary zone (marine) around Project activities.

Element	Description
	– Ongoing stakeholder engagement (e.g. Darwin Port, representative fishing bodies, etc.) to minimise third-party vessel interactions and impacts to other marine users (e.g. commercial shipping, recreational and commercial fishers, etc.). – The proposed pipeline route will be marked on marine charts, in the same way that the existing pipelines are gazetted and marked on marine charts.
Potential Cumulative Impact Summary	+ The Project is a pipeline duplication, that follows the pre-existing Bayu-Undan to Darwin pipeline and connecting into DLNG to support continuing operations; hence, cumulative impacts are expected to be minimal.
Conclusions and Forward Management	+ Project activities are compatible with the pre-existing marine and land uses of the area, following an existing pipeline corridor and within an area zoned for industrial purposes. The Project will provide a duplicate pipeline, to convey gas into the existing DLNG facility to support operations within existing approved capacity. The construction and operational Project phases will provide continued and substantive economic benefits to Darwin and the NT economy. + Santos considers potential impacts to the Community and Economy to be readily manageable, such that the NT EPA objective for this factor is able to be met with a high degree of certainty.
Culture and Heritage	
NT EPA Factor and Objective	+ Protect sacred sites, culture and heritage.
Policy and guidance	+ Heritage Act 2011 and Regulations 2012; and + Northern Territory Aboriginal Sacred Sites Act 1989 and Regulations 2004.
Assessment of Potential Impacts	<u>Construction</u> + The existing DLNG facility disturbance envelope has previously been surveyed prior to the construction of the facility to identify cultural and heritage values; hence, no values will be impacted. + Santos has been proactively engaging with AAPA, as well as traditional land owners. Through consultation with the APPA as part of pre-referral engagement, it has been confirmed that an AAPA Certificate for the entire Project Area is required. Santos is in the process of preparing an application to AAPA, at the time of this referral. + The location of shipwrecks within Darwin Harbour and surrounds is well understood and the proposed pipeline route and spoil disposal grounds avoid known shipwrecks. <u>Operation</u> + Operational activities are unlikely to impact cultural or heritage values as described above for construction activities.
Environmental Management and Mitigation	+ Stakeholder engagement plan to continue through Project planning and execution. + Dedicated stakeholder engagement liaison. + Project activities within the DLNG disturbance envelope will be managed in accordance with existing land access agreements with traditional owners. + The proposed pipeline route avoids identified Aboriginal sacred sites, as well as known European heritage sites such as shipwrecks. + Santos will obtain a Authority Certificate from AAPA prior to the commence of pre-lay construction works. + Mooring procedure will be developed to allow safe anchoring of vessels undertaking pipelay, trenching and related marine activities in the vicinity of known cultural or heritage sites of significance.
Potential Cumulative Impact Summary	+ The Project will avoid identified cultural and heritage sites of significance, honour existing land access agreements, and obtain all necessary development permits/certificates; hence cumulative impacts to cultural and heritage values are not expected.
Conclusions and Forward Management	+ Project activities are compatible with the pre-existing marine and land uses of the area, following an existing pipeline corridor and within an area zoned for industrial purposes. The cultural and heritage values within the Project Area are considered to be well understood, as are the associated regulatory/ management requirements (i.e. AAPA certification). Santos will continue to implement the Project Stakeholder Engagement Plan (SEP) to ensure this remains the case. Hence, Santos considers that potential impacts to Culture and Heritage are readily manageable, such that the NT EPA objective for this factor is able to be met with a high degree of certainty.

Appendix H – Threatened and Migratory Species – Likelihood of Occurrence Assessment

For the purposes of an NT EPA referral a high-level desktop assessment was undertaken to determine the likelihood of the species listed in the PMST would be to occur within the Project Area. This process has been adopted by multiple consultants over multiple projects in the Northern Territory. The process was adopted based on likelihood assessments undertaken in the Darwin Harbour during previous infrastructure projects being the Darwin Ship Lift Facility and Marine Industries Project and the Ichthys Project, as per the following:

- KBR (2018), Kellogg, Brown & Root Pty Ltd (KBR), 2018, Darwin Ship Lift Facility and Marine Industries Project –Notice of Intent, prepared for Northern Ship Support Pty Ltd
- AECOM (2021), AECOM 2021 Draft Environmental Impact Statement. Darwin Ship Lift prepared for Department of Chief Minister and Cabinet.
- Acer Vaughan Consulting Engineers and Consulting Environmental Engineers 1993, Draft Environmental Impact Statement, Darwin Port Expansion – East Arm, Prepared for the Northern Territory Department of Transport & Works, Darwin, Northern Territory.
- INPEX 2010, Ichthys Gas Field Development Project: Draft Environmental Impact Statement, INPEX Browse, Ltd.
- URS 2002, Darwin 10 MTPA LNG facility: public environmental report, Report prepared by URS Australia Pty Ltd for Phillips Petroleum Company Australia Pty Ltd, Darwin, Northern Territory.

Threatened and Migratory Species – Likelihood of Occurrence Assessment

Common Name	Scientific Name	TPWC Act	EPBC Act	Description/Habitat	Likelihood of Occurrence
Reptiles					
Flatback Turtle	*Natator depressus*	VU/M	VU/M	Flatback Turtles frequent the waters of Darwin Harbour but the lack of sandy beaches within the Harbour inhibits nesting activity.	**Likely** - No important habitat (foraging or nesting) for the species occurs within the Project Area. Individuals are likely to be sighted transiting through the area as they move through foraging areas.
Green Turtle	*Chelonia mydas*	Not listed	VU/M	Green Turtles spend their first five to ten years drifting on ocean currents. During this pelagic (ocean-going) phase, they are often found in association with driftlines and rafts of Sargassum (a floating marine plant that is also carried by currents). Once Green Turtles reach 30 to 40 cm curved carapace length, they settle in shallow benthic foraging habitats such as tropical tidal and sub-tidal coral and rocky reef habitat or inshore seagrass beds. In Australia, there are seven regional populations of green turtles that nest in different areas; the southern Great Barrier Reef, the northern Great Barrier Reef, the Coral Sea, the Gulf of Carpentaria, Western Australia's north-west shelf, the Ashmore and Cartier Reefs and Scott Reef.	**Unlikely** - No suitable habitat (foraging or nesting) for the species occurs within the Project Area. The species is not known from the Darwin Harbour area.
Hawksbill Turtle	*Eretmochelys imbricata*	VU	VU/M	Post-hatchling turtles spend several years in the pelagic environment often in association with rafts of Sargassum. Once Hawksbill Turtles reach 30-40 cm curved carapace length, they enter benthic foraging habitat on coral and rocky reefs habitat in tropical and subtropical waters (sometimes temperate waters) where they will remain for decades. Two major breeding areas occur in Australia: Northern Great Barrier Reef and on the North-West Shelf of WA.	**Unlikely** - No suitable habitat (foraging or nesting) for the species occurs within the Project Area. The species is not known from the Darwin Harbour area.
Leatherback Turtle	*Dermochelys coriacea*	CE	EN/M	Occurs in all coastal waters of Australia, with most sightings in temperate waters. Most of the nesting in Australia appears to be low density and there are no major nest sites recorded in Australia. Although nesting is mostly confined to tropical beaches, there are records of nests in northern NSW.	**Unlikely** - No suitable habitat (foraging or nesting) for the species occurs within the Project Area. The species is not known from the Darwin Harbour area.
Loggerhead Turtle	*Careta Caretta*	VU	EN/M	Occurs in tropical and warm temperate waters off the Australian coast. This species chooses a wide variety of tidal and sub-tidal habitat as feeding areas. The female comes ashore to lay her eggs in a hole dug on open, sandy beaches. In Australia there are two unique breeding populations: Eastern (Mon Repos, Wreck Rock, Wreck Island) and Western (Muiron Islands, Ningaloo Coast south to about Carnarvon and islands near Shark Bay).	**Unlikely** - No suitable habitat (foraging or nesting) for the species occurs within the Project Area. The species is not known from the Darwin Harbour area.
Olive Ridley Turtle	*Lepidochelys olivacea*	EN/M	EN/M	Nests in sandy beaches and resides in coastal zones along the northern coast of Australia. Mostly forages in shallow benthic habitats and also in pelagic foraging habitats. There are four major nesting areas in Australia: East coast from Mon Repos in the south to Herald Island in the north, North-Eastern Gulf of Carpentaria and western Torres Strait (the largest), western NT, and in the Kimberly and Pilbara regions of WA.	**Likely** - No important habitat (foraging or nesting) for the species occurs within the Project Area. Individuals are likely to be sighted transiting through the area as they move through foraging areas.

Common Name	Scientific Name	TPWC Act	EPBC Act	Description/Habitat	Likelihood of Occurrence
Plains Death Adder	*Acanthophsis hawkei*	VU	VU	Prefers flat, treeless, cracking soil riverine floodplains	**Unlikely** – Whilst the species has been recorded within 5km of the preferred route alignment for the Project Area, there is no suitable habitat within the Project Area
Yellow-spotted monitor*	*Varanus panoptes*	Not listed	VU	This species has been recorded across most of the Top End and the Gulf Region in a variety of habitats, including coastal	**Unlikely** – The species has been recorded within 5km of the preferred route alignment for the Project Area. The species may use suitable habitat in the project area from time to time. There will be a lack of suitable habitat during the dry season when all of the waterways in the area are completely dry.
Mammals					
Bare-rumped Sheath-tailed Bat	*Saccolaimus saccolaimus*	VU	Not listed	Open Pandanus woodland fringing the and eucalypt tall open forests. It roosts in tree hollows and caves.	**Unlikely** - no suitable habitat within the Project Area, given the onshore/shore crossing location is within the existing DLNG disturbance envelope.
Black-footed Tree-rat	*Mesembriomys gouldii*	EN	VU	Occurs in the Top End of the NT in tropical woodlands and open forests in coastal areas.	**Unlikely** - no suitable habitat within the Project Area, given the onshore/shore crossing location is within the existing DLNG disturbance envelope.
Blue Whale	*Balaenoptera musculus*	Not listed	EN/M	The blue whale is found in every ocean except the arctic, with a range that extends from the periphery of drift-ice in polar seas to the tropics. It follows seasonal migration pattern between summering and wintering areas although some individuals may remain in certain areas year-round. They mate and calve in tropical-to-temperate waters during winter months and feed in polar waters during summer months.	**Unlikely** - The species is unlikely to occur within the Project Area as its preferred habitat is open ocean. It is seen to occur further offshore within Commonwealth waters.
Brush-tailed Rabbit-rat	*Conilurus penicillatus*	VU	EN	The preferred habitat is eucalypt tall open forest, has been known to also occur on coastal grasslands with scattered large *Casuarina equisetifolia* trees, beaches, and stunted eucalypt woodlands on stony slopes. It shelters in tree hollows, hollow logs and, less frequently, in the crowns of pandanus or sand palms.	**Unlikely** – Suitable habitat may be available; however, this species appears to be restricted to the Coburg Peninsula and some islands.
Fawn Antechinus	*Antechinus bellus*	VU	EN	Occurs in savannah woodland and tall open forest of the Top End of the NT, shelters in tree hollows and fallen logs, shows a preference for areas exposed to cooler and less frequent fires.	**Unlikely** - no suitable habitat within the Project Area, given the onshore/shore crossing location is within the existing DLNG disturbance envelope.
Fin Whale	*Balaenoptera physalus*	Not listed	VU/M	The North Atlantic fin whale has an extensive distribution, occurring from the Gulf of Mexico and Mediterranean Sea, northward to Baffin Bay and Spitsbergen. In general, fin whales are more common north of approximately 30°N latitude, but considerable confusion arises about their occurrence south of 30°N latitude because of the difficulty in distinguishing fin whales from Bryde's whales.	**Unlikely** - The species is unlikely to occur within the Project Area as its preferred habitat is open ocean. It is seen to occur further offshore within Commonwealth waters.
Ghost Bat	*Macroderma gigas*	VU	Not listed	The distribution of this species is influenced by the availability of suitable caves and mines for roost sites. Daytime roosts may change seasonally. One of the largest known colonies occurs in a series of gold mine workings at Pine Creek in the Northern Territory.	**Unlikely** - no suitable habitat within the Project Area, given the onshore/shore crossing location is within the existing DLNG disturbance envelope.
Humpback Whale	*Megaptera novaeangliae*	Not listed	VU/M	Occurs in oceanic and coastal waters around the world. Australia has two distinct Humpback Whale populations which throughout all coastal waters surrounding Australia; east coast and west coast. Camden sound appears to be the northern most limit for the majority of the west coast whales and is considered to be an important breeding area. The migratory habitat for the humpback whale around mainland Australia is primarily coastal waters less than 200m in depth and generally within 20km of the coast .	**Unlikely** - The species is unlikely to occur within the Project Area as its preferred habitat is open ocean. It is seen to occur further offshore within Commonwealth waters.
Nabarlek (Top End)	*Petrogale concinna*	EN	VU	Nabarleks are restricted to rocky areas, especially on steep slopes, with large boulders, caves and crevices. They may move from these to forage in adjacent flat areas.	**Unlikely** - no suitable habitat within the Project Area
Northern Brush-tailed Possum	*Trichosurus vulpecula arnhemensis*	Not listed	VU	Most records are from tall open forests dominated by *Eucalyptus miniata and E. tetrodonta.*	**Unlikely** – the species is unlikely to be present in light of recent reductions in range
Northern Quoll	*Dasyurus hallucatus*	EN	CE	This species formerly occurred across much of northern Australia, from south-eastern Queensland to the south-west Kimberley, with a disjunct population in the Pilbara. The most suitable habitats appear to be rocky areas.	**Unlikely** – whilst the species has historically been recorded within 5km of the Project Area the species is unlikely to be present in light of recent reductions in range

Common Name	Scientific Name	TPWC Act	EPBC Act	Description/Habitat	Likelihood of Occurrence
Sei Whale	*Balaenoptera borealis*	Not listed	VU/M	Sei whales have been infrequently recorded in Australian waters. Typically occur within deeper offshore waters.	**Unlikely** - The species is unlikely to occur within the Project Area as its preferred habitat is open ocean.
Water Mouse / False Water Rat	*Xeromys myoides*	VU	Not listed	Mangrove forests, freshwater swamps and floodplain saline grasslands.	**Unlikely** – the species has not been recorded within 5km of the Project Area and there is no suitable habitat on the leases.
Birds					
Australian Painted Snipe	*Rostratula australis*	VU	VU	Shallow, vegetated, freshwater swamps, claypans or inundated grassland	**Unlikely** – No suitable habitat within the Project Area
Curlew Sandpiper	*Calidris ferruginea*	CE	VU	Fresh and brackish water, can include ephemeral and permanent lakes, dams, waterholes and bore drains, usually with bare edges of mud or sand	**Unlikely** – Whilst the species has been recorded within 5km of the Project Area, there is no suitable habitat within the Project Area
Eastern Curlew	*Numenius madagascariensis*	CE	VU/M	They are most common in mangrove areas but will also forage on intertidal flats and saltmarshes.	**Unlikely** – Whilst the species has been recorded within 5km of the Project Area, there is no suitable habitat within the Project Area
Gouldian Finch	*Erythrura gouldiae*	EN	VU	The species forages in open woodland with groundcover of *Sorghum* and other annual and perennial grasses. Nests in hollows in *Eucalyptus tintinnans.*	**Unlikely** – Whilst the species has been recorded within 5km of the Project Area, there is no suitable habitat within the Project Area
Great Knot	*Calidris tenuirostris*	CR	VU/M	Migratory species. In the NT birds settle on large sheltered intertidal mudflats and sandflats, especially in mangrove areas.	**Unlikely** – Whilst the species has been recorded within 5km of the Project Area, there is no suitable habitat within the Project Area
Greater Sand Plover	*Charadrius leschenaultii*	VU	VU/M	In the NT, Greater Sand Plovers have been recorded from most of the coastline. In the NT they forage along sandy beaches and sheltered mudflats and have been reported them occasionally also using inland saline wetlands but always close to the coast.	**Unlikely** – Whilst the species has been recorded within 5km of the Project Area, there is no suitable habitat within the Project Area
Grey Falcon	*Falco hypoleucos*	VU	VU	Occurs in lightly timbered lowland plains, typically on inland drainage systems, where the average annual rainfall is less than 500 mm.	**Unlikely** – Has not been recorded within 5km of the project area and suitable habitat does not occur within the Project Area.
Lesser Sand Plover	*Charadrius mongolus*	EN	VU/M	Migratory species. In the NT the birds forage on sheltered mudflats, sandy beaches, estuaries and mangroves. They have also been reported to use inland saline wetlands occasionally but always close to the coast.	**Unlikely** – Whilst the species has been recorded within 5km of the Project Area, there is no suitable habitat within the Project Area
Masked Owl (mainland Top End)	*Tyto novaehollandiae kimberli*	VU	VU	Occurs mainly in eucalypt tall open forests (especially those dominated by Darwin woollybutt *Eucalyptus miniata* and Darwin stringybark E. *tetrodonta*), but also roosts in monsoon rainforests, and forages in more open vegetation types, including grasslands. Although it may roost in dense foliage, it more typically roosts, and nests, in tree hollows.	**Unlikely** - no suitable habitat within the Project Area
Nunivak Bar-tailed Godwit, Western Alaskan Bar-tailed Godwit	*Limosa lapponica baueri*	VU	VU	Widespread in coastal areas such as wetlands, however predominantly found in New Zealand during breeding season.	**Unlikely** - no suitable habitat within the Project Area
Partridge Pigeon	*Geophaps smithii*	VU	VU	Occurs in open forest and woodland dominated by *Eucalyptus tetrodonta* and *E. miniata* with a structurally diverse understorey.	**Unlikely** - no suitable habitat within the Project Area
Red Gosshawk	*Erythrotriorchis radiatus*	VU	VU	Forest and woodland with a mosaic of vegetation types, including eucalypt woodland, open forest, gallery rainforest, swamp sclerophyll forest and rainforest margins.	**Unlikely** - no suitable habitat within the Project Area
Red Knot	*Calidris canutus*	EN	VU/M	Migratory species. In the NT birds settle on large sheltered intertidal mudflats and sandflats and are rarely encountered far from the coast.	**Unlikely** – Whilst the species has been recorded within 5km of the Project Area, there is no suitable habitat within the Project Area
Sharks					
Dwarf Sawfish	*Pristis clavata*	VU	VU/M	The species' Australian distribution is considered to extend north from Cairns around the Cape York Peninsula in QLD, across northern Australian waters to the Pilbara coast in Western Australia. The species usually inhabits shallow (2–3 m) coastal waters and estuarine habitats. The species does not utilise any purely freshwater areas, as its range is restricted to brackish and salt water.	**Unlikely** - Individuals of this species have been recorded in the Darwin Harbour Region. The Project Area does not contain key habitat resources for this species for foraging or breeding. Individuals of this species may occur in the Project Area as it searches for suitable foraging areas. The closest known record is over 10 km from the Project Area.

Common Name	Scientific Name	TPWC Act	EPBC Act	Description/Habitat	Likelihood of Occurrence
Freshwater Sawfish	*Pristis pristis*	VU	VU/M	The freshwater Sawfish may potentially occur in all large rivers of northern Australia from the Fitzroy River, WA, to the western side of Cape York Peninsula, QLD. The name Freshwater Sawfish is a misnomer. It is a marine/estuarine species that spends its first 3-4 years in freshwater then the larger mature animals tend to occur more often in coastal and offshore waters up to 25 m depth. Freshwater Sawfish occur in fresh or weakly saline. The species tends to move up rivers during flood periods. Small specimens, mostly less than 150 cm, have been caught in remote ponds where they have been isolated for several years between floods.	**Unlikely** - Individuals of this species have been recorded in the Darwin Harbour Region. The Project Area does not contain key habitat resources for this species for foraging or breeding. Individuals of this species may occur in the Project Area as it searches for suitable foraging areas. The closest known record is over 20 km away from the project area.
Great White Shark	*Carcharodon carcharias*	Not Listed	VU/M	In Australia, Great White Sharks have been recorded from central QLD around the south coast to north-west WA but may occur further north on both coasts. It has been sighted in all coastal areas except in the NT. The Great White Shark moves seasonally along the south and east Australian coasts, moving northerly along the coast during autumn and winter and returning to southern Australian waters by early summer. Found from close inshore around rocky reefs, surf beaches and shallow coastal bays to outer continental shelf and slope areas. They also make open ocean excursions and can cross ocean basins (e.g. South Africa to WA). Often found in regions with high prey density	**Unlikely** - The species is unlikely to occur within the Project Area as its preferred habitat is open ocean and is not typically off the Northern Territory coast.
Green Sawfish	*Pristis zijsron*	VU	VU/M	The Green Sawfish was once widely distributed but it is now thought that northern Australia may be the last region where significant populations of Green Sawfish exist. They inhabit muddy bottom habitats and also enter estuaries where they can be found in shallow water. Its habitat is heavily fished and often subject to pollution, habitat loss and degradation.	**Unlikely** - Individuals of this species have been recorded in the Darwin Harbour Region. The Project Area does not contain key habitat resources for this species such as foraging or breeding. Individuals of this species may occur in the Project area as it searches for suitable foraging areas. The closest known record is over 20 km from the Project Area.
Northern River Shark	*Glyphis garricki*	EN	EN	The species is known only from a small number of locations in WA, NT and PNG. Since its discovery in 1986, only 36 specimens have been recorded. Little is known of the ecology of the northern river shark but it is probably restricted to shallow, brackish reaches of large rivers. This conclusion is based on the fact that it has not yet been caught in the coastal marine areas despite considerable fishing and collecting activity in these habitats. In the NT this species is only known within the from the Adelaide and East and South Alligator River systems	**Unlikely** - While individuals of this species of have been recorded in the broader Darwin area, these records are located well away from the Project Area in different habitat then what is found in the Project Area. This species is not known in the Darwin Harbour area.
Speartooth Shark	*Glyphis glypis*	Not Listed	CE/M	Predominantly occurs within tidal rivers and estuaries within the Northern Territory.	**Potential** – Potential to occur within Darwin Harbour.
Whale Shark	*Rhincodon typus*	Not Listed	VU/M	In Australia, the Whale Shark is known from NSW, QLD, NT, WA and occasionally VIC and Southern Australia, but is most commonly seen in waters off northern WA, NT and QLD. The Whale Shark seasonally aggregates in coastal waters off Ningaloo Reef between March and July each year, at Christmas Island between December and January, and in the Coral Sea between November and December. The Whale Shark is an oceanic and coastal, tropical to warm-temperate pelagic hark.	**Unlikely** - The species is unlikely to occur within the Project Area as its preferred habitat is open ocean.
Migratory Marine Birds					
Common Noddy, Brown Noddy	*Anous stolidus*	Not Listed	M	Tropical seabird with worldwide distribution. They breed on tropical and subtropical inshore or oceanic islands, which have rocky cliffs and coral or sand beaches. It nests on the ground, in trees or shrubs, and on cliffs or man-made structures, such as docks and jetties. During the non-breeding season, they will spend most of its time at sea and may roost on water, rocks, islets, flotsam and even the backs of sea turtles.	**Unlikely** - The project area does not contain suitable habitat for the species, given it is located within the existing DLNG facility disturbance envelope and the species may only be seen transiting the area, but is unlikely to land onshore with no suitable foraging habitat present.
Fork-tailed swift	*Apus pacificus*	Not Listed	M	They spend most of the year relatively high in the air column, only coming down to near ground level at times of bad weather. Seen over open country from semi deserts to coasts, islands and sometimes over forests and cities.	**Unlikely** - Species is aerial and unlikely to be found within the Project Area but may be observed as an overhead visitor.
Great Frigatebird, Great Frigatebird	*Fregata minor*	Not Listed	M	It is a widespread seabird, with major colonies in the Indian Ocean, West and Central Pacific and Southern Atlantic. They inhabit remote islands in tropical and sub-tropical seas, where it breeds in small bushes, mangroves and even on the ground.	**Unlikely** - Limited suitable habitat is present in the Project Area. The species has not been recorded in the Darwin region in the last 30 years

Common Name	Scientific Name	TPWC Act	EPBC Act	Description/Habitat	Likelihood of Occurrence
Lesser Frigatebird, Least Frigatebird	*Fregata ariel*	Not Listed	M	It is a widespread seabird, with major colonies in the Indian Ocean, West and Central Pacific and Southern Atlantic. They inhabit remote islands in tropical and sub-tropical seas, where it breeds in small bushes, mangroves and even on the ground. Outside the breeding season it is sedentary, with immature and non-breeding individuals dispersing throughout tropical seas.	**Unlikely** - Limited suitable habitat is present in the Project Area. The species has not been recorded in the Darwin region in the last 15 years.
Little Tern	*Sternula albifrons*	Not Listed	M	Inhabits coastal waters, bays, inlets, saline or brackish lakes, salt fields and sewage ponds near coast throughout northwest, north, east and southeast Australia. It can also be found further inland, sometimes up to several kilometres from the sea.	**Unlikely** - Limited suitable habitat is present in the Project Area. The species has not been recorded in the Darwin region in the last 15 years.
Streaked Shearwater	*Calonectris leucomelas*	Not Listed	M	This species is pelagic and abundant off the north coasts of Australia from November to May. Occurs -on the west and east coasts in summer. Species is abundant off northern Australian coasts.	**Unlikely** - The project area does not contain suitable habitat for the species.
Migratory Marine Species					
Australian Snubfin Dolphin	*Orcaella heinsohni*	Not Listed	M	They occur in inshore coastal areas and some rivers from eastern India to north-eastern Australia and through southeast Asia to Vietnam. Inhabits coastal, brackish and freshwaters of the tropical and subtropical Indo-Pacific. A substantial population was located in the western Gulf of Carpentaria, and another in Blue Mud Bay. The species lives in brackish waters near coasts, river mouths and in estuaries.	**Likely** - Suitable habitat for the species is present. Individuals of the species have previously been recorded near Catalina Island, located to the east on the Project Area.
Bryde's Whale	*Balaenoptera edeni*	Not Listed	M	The Bryde's whale can be found in tropical and sub-tropical waters throughout the Atlantic, Pacific and Indian Oceans. There appear to be two distinct habitat preferences amongst Bryde's whales, with some populations, usually comprising smaller-bodied individuals, occurring in coastal waters, while other populations can be found in the open ocean, however all Bryde's whales have a preference for warmer water above 16.3 Degrees Celsius.	**Unlikely** - No suitable habitat is present within the Project Area.
Dugong	*Dugong dugon*	Not Listed	M	Shallow, warm (18ºC or above) tropical and sub-tropical coastal waters of the Indian and western Pacific Oceans. Generally occurs in wide shallow protected bays and mangrove channels that support extensive sea grass meadows. Reported to use shallow waters such as tidal sandbanks and estuaries for calving. Australian range from Shark Bay, WA to Moreton Bay, QLD. Occurs in warmer waters south from the Indo-West Pacific to northern NSW.	**Likely** - Individuals of the species are known to occur within the Darwin Harbour and will likely transit the Project area. However, the Project area does not contain key habitat resources for the species such as seagrass and algae foraging areas. Individuals of the species may be periodically sighted offshore in the Darwin Harbour as it moves through foraging areas.
Giant Manta Ray	*Manta birostris*	Not Listed	M	This species is believed to have a wider distribution than the closely related reef manta ray, and is more migratory in its behaviour. It appears to be a seasonal visitor to coastal and offshore sites, and is commonly seen along productive coastlines with regular upwellings, as well as around oceanic islands, offshore pinnacles and seamounts.	**Unlikely** - No suitable habitat is present within the Project Area.
Indo-Pacific Humpback Dolphin	*Sousa chinensis*	Not Listed	M	The Indo-Pacific hump-backed dolphin, is found in tropical and temperate coastal waters of the Indian and Pacific Oceans from northern Australia and southern China in the east, through Indonesia, and around the coastal rim of the Indian Ocean to southern Africa. They are known to enter rivers, estuaries, and mangroves, particularly the latter. They prefer shallow waters <20 m in depth with warm temperatures between 15-36°C. The species is mostly recorded within 10 km of the coast and are on average recorded 2.8 km from the coast.	**Likely** - Suitable habitat for the species is present. The species is widely known from the Darwin Harbour.
Killer Whale, Orca	*Orcinus orca*	Not Listed	M	The orca is found throughout all the world's oceans. The orca occurs in virtually every marine region, from polar waters to the equator, and has even been known to enter bays, estuaries and rivers, as well as ice floes. However, it is most commonly recorded in coastal, temperate waters and in areas of high productivity.	**Unlikely** - The species is unlikely to occur within the Project Area as its preferred habitat is open ocean.

Common Name	Scientific Name	TPWC Act	EPBC Act	Description/Habitat	Likelihood of Occurrence
Longfin Mako	*Isurus pacus*	Not Listed	M	Widely scattered records suggest that the longfin mako shark has a worldwide distribution in tropical and warm-temperate oceans; the extent of its range is difficult to determine due to confusion with the shortfin mako. In the Atlantic Ocean, it is known from the Gulf Stream off the East Coast of the United States, the Caribbean, and southern Brazil in the west, and from the Iberian Peninsula to Ghana in the east, possibly including the Mediterranean Sea and Cape Verde. In the Indian Ocean, it has been reported from the Mozambique Channel. In the Pacific Ocean, it occurs off Japan and Taiwan, northeastern Australia, a number of islands in the Central Pacific northeast of Micronesia, and southern California.	**Potential** – Potential to occur within Darwin Harbour.
Narrow Sawfish	*Anoxypristis cuspidata*	Not Listed	M	The Narrow sawfish is found mainly in inshore coastal waters, to depths of around 40 metres, where it is thought to spend most of its time on or near the bottom. It may also enter estuaries and river deltas, and has been reported to move upstream into rivers in some areas, although its occurrence in freshwater has yet to be verified.	**Unlikely** - No suitable habitat is present within the Project Area.
Oceanic Whitetip Shark	*Carcharhinus longimanus*	Not Listed	M	The oceanic whitetip is found globally in deep, open oceans, with a temperature greater than 18 °C, although exceptionally it occurs in water as cold as 15 °C. It prefers waters between 20 and 28 °C and tends to withdraw from areas when temperatures fall outside of these limits. It was once extremely common and widely distributed, and still inhabits a wide band around the globe; however, recent studies suggest that its numbers have drastically declined. An analysis of the US pelagic longline logbook data between 1992 and 2000 (covering the Northwest and Western Central Atlantic) estimated a decline of 70% over that period.	**Potential** – Potential to occur within Darwin Harbour.
Reef Manta Ray	*Manta alfredi*	Not Listed	M	The reef manta ray is found in tropical and sub-tropical waters in the Pacific and Indian Oceans. However, within this widespread range its populations appear to be quite patchy This species is quite widespread in the Indian Ocean, from the Red Sea in the north to South Africa in the south, and from Thailand southwards to Western Australia. It is more commonly found in shallow inshore waters and typically occurs around coastal reefs, tropical island groups, atolls, bays and productive coastlines.	**Unlikely** - No suitable habitat is present within the Project Area.
Salt-water Crocodile	*Crocodylus porosus*	Not Listed	M	The saltwater crocodile is the most widely distributed crocodilian species, ranging from Sri Lanka and the east coast of India in the west, through southeast Asia to Australia. As its common name implies, the saltwater crocodile has a high tolerance for saltwater, aided by salt-excreting glands on the tongue. It may be found in brackish water around coastal areas and rivers, often amongst mangrove forest, as well as occurring further out to sea, and also occurs in freshwater rivers, lakes, swamps and marshes, up to 200 kilometres inland	**Likely** - There is no important habitat for the species located within the project area. Individuals of the species have previously been sighted on boat ramps near the project area. Individuals may also be periodically sighted inside Darwin Harbour.
Shortfin Mako	*Isurus oxyrinchus*	Not Listed	M	The shortfin mako inhabits offshore temperate and tropical seas worldwide. The closely related longfin mako shark is found in the Gulf Stream or warmer offshore waters (for ex., New Zealand and Maine)	**Potential** – Potential to occur within Darwin Harbour.
Spotted Bottlenose Dolphin	*Tursiops aduncus*	Not Listed	M	This species has been found from the west of South Africa to the southern part of Japan and the north, In Australia, the species is restricted to inshore areas such as bays and estuaries, nearshore waters, open coast environments, and shallow offshore waters including coastal areas around oceanic islands east and west of Australia including the Red Sea. Its habitat varies depending on the tides and the season but includes estuaries, coral reefs and surface waters at high seas, so it tolerates both saltwater and brackish water.	**Likely** - Suitable habitat for the species is present. The species is widely known from the Darwin Harbour.
Migratory Terrestrial/Wetland Species					
Barn Swallow	*Hirundo rustica*	Not Listed	M	Species if found sporadically throughout northern Australia during non-breeding season. The barn swallow is found in vegetated areas including farmland, sports grounds, native grasslands and airstrips as well as over open water such as billabongs, lagoons, creeks and sewage treatment plants.	**Unlikely** - The Project Area does not contain suitable habitat for this species, the closest known record is over 5 km from the Project Area.

Common Name	Scientific Name	TPWC Act	EPBC Act	Description/Habitat	Likelihood of Occurrence
Broad-billed sandpiper	*Limicola falcinellus*	Not Listed	M	Shallow, pebbly, muddy or sandy edges of rivers and streams, coastal to far inland; dams, lakes, sewage ponds; margins of tidal rivers; waterways in mangroves or saltmarsh; mudflats; rocky or sandy beaches; causeways, riverside lawns, drains and street gutters.	**Unlikely** - The Project Area does not contain suitable habitat for this species, the closest known record is over 5 km from the Project Area.
Common Greenshank	*Tringa nebularia*	Not Listed	M	Species is common throughout Australia from August till March. Found in mudflats, estuaries, saltmarshes, margins of lakes, wetlands, clay pans, fresh and salines, commercial salt fields, sewage ponds.	**Unlikely** - The Project Area does not contain suitable habitat.
Common Sandpiper	*Actitis hypoleucos*	Not Listed	M	Shallow, pebbly, muddy or sandy edges of rivers and streams, coastal to far inland; dams, lakes, sewage ponds; margins of tidal rivers; waterways in mangroves or saltmarsh; mudflats; rocky or sandy beaches; causeways, riverside lawns, drains and street gutters.	**Potential** - The Project Area does not contain suitable habitat for nesting/roosting however there is suitable habitat for foraging on either side of the Project Area which may result in this species traversing the Project Area footprint.
Grey Plover	*Pluvialis squatarola*	Not Listed	M	Grey Plovers occur almost entirely in coastal areas, where they usually inhabit sheltered embayments, estuaries and lagoons with mudflats and sandflats, and occasionally on rocky coasts with wave-cut platforms or reef-flats, or on reefs within muddy lagoons. They also occur around terrestrial wetlands such as near-coastal lakes and swamps, or saltlakes.	**Potential** - The Project Area does not contain suitable habitat for nesting/roosting however there is suitable habitat for foraging on either side of the Project Area which may result in this species traversing the Project Area footprint.
Grey-tailed Tattler	*Tringa brevipes*	Not Listed	M	Found in estuaries, tidal mudflats, mangroves, wave-washed rocks and reefs, shallow river margins, coastal or inland. In Australia adults arrive in the north coast from late Aug to early Sep.	**Unlikely** - The Project Area does not contain suitable habitat.
Grey Wagtail	*Motacilla cinerea*	Not Listed	M	Found near running water, disused quarries, sandy rocky streams in escarpments and rainforests, sewage ponds, ploughed fields and airfields. Visitor to Australia from November to April.	**Unlikely** - The Project Area does not contain suitable habitat.
Little Curlew	*Numenius minutus*	Not Listed	M	The Little Curlew is most often found feeding in short, dry grassland and sedgeland, including dry floodplains and black soil plains, which have scattered, shallow freshwater pools or areas seasonally inundated. Open woodlands with a grassy or burnt understorey, dry saltmarshes, coastal swamps, mudflats or sandflats of estuaries or beaches on sheltered coasts, mown lawns, gardens, recreational areas, ovals, racecourses and verges of roads and airstrips are also used.	**Unlikely** - While the Project Area does contain some attributes which are known to be utilised by this species (i.e. mudflats), they typically prefer to forage in short grasses which are not present at the site. The closest known record of this species is over 5 km from the Project Area and was recorded 10 years ago.
Little Ringed Plover	*Charadrius dubius*	Not Listed	M	Open plains; bare rolling country, often far from water; ploughed land; muddy or sandy wastes near inland swamps or tidal mudflats; bare clay pans; margins of coastal marshes; grassy airfields, sports fields and lawns. They are a regular summer migrant to Australia from Sep-Mar.	**Unlikely** - The Project Area does not contain suitable habitat.
Long-toed Stint	*Calirdirs subminuta*	Not Listed	M	The long-toed stint breeds in Siberia during the Northern Hemisphere summer. It is a visitor to New Guinea and Australia and a vagrant to Sweden, South Africa, Melanesia, Hawaii, the northwestern USA and the vicinity of the Bering Sea. In its over-wintering range it visits a variety of wetland habitats including shallow freshwater or brackish areas, lakes, swamps, floodplains, marshes, lagoons, muddy shores and sewage ponds.	**Unlikely** - The Project Area does not contain suitable habitat.
Marsh Sandpiper	*Tringa stagnatilis*	Not Listed	M	It is a migratory species, with majority of birds wintering in Africa, and India with fewer migrating to Southeast Asia and Australia. They prefer to winter on freshwater wetlands such as swamps and lakes and are usually seen singly or in small groups. These birds forage by probing in shallow water or on wet mud. They mainly eat insects, and similar small prey.	**Unlikely** - The Project Area does not contain suitable habitat.
Oriental, Horsfield's Cuckoo	*Cuculus optatus*	Not Listed	M	Treated as conspecific with C. saturatus (Himalayan Cuckoo). Inhabits monsoon forests and rainforest edges; leafy trees in paddocks; river flats, roadsides, mangroves and islands.	**Unlikely** - The Project Area does not contain suitable habitat for this species, the closest known record is over 5 km from the Project Area.

Common Name	Scientific Name	TPWC Act	EPBC Act	Description/Habitat	Likelihood of Occurrence
Oriental Pratincole	*Glareola maldivarum*	Not Listed	M	Usually inhabits open plains, floodplains or short grassland, often with extensive bare areas. Often occur near terrestrial and artificial wetlands, especially around the margins. This species also occurs along the coast, inhabiting beaches, mudflats and islands, or around coastal lagoons. Does not breed in Australia.	**Unlikely** - The Project Area does not contain suitable habitat for this species, the closest known record is over 10 km from the Project Area. This observation was recorded 15 years ago.
Oriental Reed-Warbler	*Acrocephalus orientalis*	Not Listed	M	Rare migrant to coastal North and eastern Australia. Found in dense reeds, cumbungi, over and near water. It breeds mainly in reed beds and can also be found in marshes, paddy fields, grassland and scrub where it forages for insects and other invertebrates.	**Unlikely** - The Project Area does not contain suitable habitat.
Osprey	*Pandion haliaetus*	Not Listed	M	Treated as conspecific with P. Cristatus. The Osprey is thinly distributed around the coast of Australia where they forage for fish in fresh, brackish, or saline waters of rivers, lakes, estuaries and inshore coastal waters. Nests are usually located near a suitable area of foraging habitat and are a bulky structure made from piled sticks, often positioned in a tall dead tree or artificial structures such as telecommunication towers or poles. Breeding pairs defend breeding territory against other Ospreys, and active nests are usually more than 1 km apart.	**Potential** - The Project Area does not contain suitable habitat for nesting/roosting. It is noted that there is an Osprey nest on the DLNG site.
Pacific golden Plover-	*Pluvialis fulva*	Not Listed	M	This species usually inhabits coastal habitats, though it occasionally occurs around inland wetlands. Usually occur on beaches, mudflats and sandflats in sheltered areas including harbours, estuaries and lagoons, and also in evaporation ponds in saltworks. The species is also sometimes recorded on islands, sand and coral cays and exposed reefs and rocks. Breeding occurs in dry areas of tundra away from the coast, usually on slopes of low hills, knolls or foothills vegetated with lichen and moss, or in bare, stony areas.	**Unlikely** - The Project Area does not contain suitable habitat.
Pectoral Sandpiper	*Calidris melanotos*	Not Listed	M	Species has patchy distribution around Australia's coastline. Found in shallow fresh waters, often with low grass and other herbage; swamp margins, flooded pastures, sewage ponds; occasionally tidal areas and saltmarshes.	**Unlikely** - The Project Area does not contain suitable habitat for the species.
Pin-tailed Snipe	*Gallinago stenura*	Not Listed	M	Pin-tailed Snipe occurs most often in or at the edges of shallow freshwater swamps, ponds and lakes with emergent, sparse to dense cover of grass/sedge or other vegetation. The species is also found in drier, more open wetlands such as clay pans in more arid parts of species' range. It is also commonly seen at sewage ponds; not normally in saline or inter-tidal wetlands	**Unlikely** - The Project Area does not contain suitable habitat for the species, the closest known record is over 10 km from the project area.
Red-necked Stint	*Calidris ruficollis*	Not Listed	M	Species are found in tidal mudflats, saltmarshes; sandy or shelly beaches; saline and freshwater wetlands, coastal and inland; salt fields and sewage ponds. They are often in dense flocks, feeding or roosting. Spends the southern summer months in Australia and is found widely except in the arid inland.	**Unlikely** - The Project Area does not contain suitable habitat for the species, the closest known record is over 10 km from the project area.
Red-rumped Swallow	*Cecropis daurica*	Not Listed	M	Migratory bird that spends the winter months in northern Australia. This species is found in open hilly country and mountains, river gorges, valleys, sea cliffs, as well as in cultivated areas and human habitations, including towns.	**Unlikely** - The Project Area does not contain suitable habitat.
Ruddy Turnstone	*Arenaria interpres*	Not Listed	M	Winters on Australian coastlines. Tidal reefs and pools, weed covered rocks, pebbly shelly and sandy shores with stranded seaweed, mudflats, occasionally inland on shallow waters, sewage ponds, commercial salt fields, open or ploughed ground.	**Unlikely** - The Project Area does not contain suitable habitat.
Rufous Fantail	*Rufous rufifrons*	Not Listed	M	The rufous fantail inhabits moist and moderately dense habitats. Within these areas, it has astonishingly large variations in habitat requirements. They can be found in eucalyptus forests, mangroves, rainforests and woodlands (usually near a river or swamp).	**Unlikely** - The Project Area does not contain suitable habitat.
Sanderling	*Calidris alba*	Not Listed	M	Broad ocean beaches of firm sand 'where waves ebb and flow', depositing strands and heaps of seaweed; often near river mouths; also inlets, tidal mudflats and coastal lagoons.	**Unlikely** - The Project Area does not contain suitable habitat.

Common Name	Scientific Name	TPWC Act	EPBC Act	Description/Habitat	Likelihood of Occurrence
Sharp-tailed Sandpiper	*Calidris acuminata*	Not Listed	M	The sharp-tailed sandpiper breeds in northern Siberia but migrates south to winter in Australia and New Zealand. In the non-breeding season they can be found in tidal mudflats, saltmarshes, mangroves; shallow fresh, brackish or saline inland wetlands; floodwaters, irrigated pastures and crops; sewage ponds and salt fields.	**Unlikely** - The Project Area does not contain suitable habitat.
Swinhoe's Snipe	*Gallinago megala*	Not Listed	M	Found on northern Australian coastlines. Non-breeding habitats include shallow freshwater wetlands of various kinds including paddy fields and sewage farms, with bare mud or shallow water for feeding, with nearby vegetation cover.	**Unlikely** - The Project Area does not contain suitable habitat for the species, the closest known record is over 10 km from the Project Area.
Terek Sandpiper	*Xenus cinereus*	Not Listed	M	In Australia, the Terek Sandpiper has been recorded on coastal mudflats, lagoons, creeks and estuaries. Records indicate that the species favours muddy beaches near mangroves but may also be observed on rocky pools and coral reefs and occasionally up to 10km inland around brackish pools.	**Unlikely** - The Project Area does not contain suitable habitat.
Wandering Tattler	*Tringa incana*	Not Listed	M	Non-breeding habitats include shallow freshwater wetlands of various kinds including paddy fields and sewage farms, with bare mud or shallow water for feeding, with nearby vegetation cover.	**Unlikely** - The Project Area does not contain suitable habitat.
Whimbrel	*Numenius phaeopus*	Not Listed	M	Estuaries, mangroves, tidal flats, coral cays, exposed reefs, flooded paddocks, sewage ponds, bare grasslands, sports grounds and lawns.	**Unlikely** - The Project Area does not contain suitable habitat.
Wood Sandpiper	*Tringa glareola*	Not Listed	M	In Australia, the Terek Sandpiper has been recorded on coastal mudflats, lagoons, creeks and estuaries. Records indicate that the species favours muddy beaches near mangroves but may also be observed on rocky pools and coral reefs and occasionally up to 10km inland around brackish pools.	**Unlikely** - The Project Area does not contain suitable habitat.
Yellow Wagtail	*Motacilla flava*	Not Listed	M	Regular summer migrant to coastal Australia, especially Darwin to Broome, but also north-eastern Queensland from November to April. Found in short grass and bare ground, swamp margins, sewage ponds, saltmarshes, playing fields, airfields, ploughed land and town lands.	**Unlikely** - The project area does not contain suitable habitat for the species with the closest known record over 10 km from the Project Area. This observation was recorded 30 years ago.

CE – Critically Endangered
EN – Endangered
VU – Vulnerable
M - Migratory

Appendix I – Risk Assessment Framework

Environmental Risk Framework

Purpose of the Environmental Risk Framework

The purpose of this environmental risk framework section is to outline the approach used for the assessment of potential impacts of the Project in relation to the NT EPA key environmental factors and objectives, namely Coastal Processes, Marine Environmental Quality and Marine Ecosystems. The framework has been adapted from Santos' environmental risk assessment process to include consequence descriptors relevant to the Project. A residual risk rating has been determined based on the greatest impact for each of the key environment factors and objectives.

Santos Environmental Risk Process

The methodology for this assessment is based on the requirements of AS/NZS 4360:2004 (Risk Management).

The environmental risk framework sets out a method to:

+ establish boundaries for the definition of risk likelihoods and consequences.
+ identify the type of risks associated with the Project.
+ evaluate the risks by ranking them according to the likelihood of the risk and its consequence.
+ outline management measures to mitigate risks to an acceptable level.
+ determine the residual level of risk after application of management measures.

The assessment of risk requires a level of understanding of the nature of activities and how they may interact with the environment, and looks at the causal effect between the aspect (e.g. hazard) and the identified receptor. Impact mechanisms and impacts are determined and described, using scientific literature and modelling where required.

The consequence level of the impact is then determined for each aspect using the Santos Environment Consequence Descriptors (**Table 3**) and applied to the following receptor categories:

+ threatened/migratory/local fauna.
+ physical environment/habitat.
+ threatened ecological communities.
+ protected areas.
+ socio-economic receptors.

The level of information required to complete the impact or risk assessment depends on the nature and scale of the impact or risk. This process determines a consequence level based on set criteria for each receptor category and takes into consideration the duration and extent of the impact, receptor recovery time and the effect of the impact at a population, ecosystem or industry level. Impacts to social and economic values are also considered based on existing knowledge and feedback from stakeholder consultation. As the result of historic consultation with stakeholders, the social and economic values in the region that are of interest are evident.

As planned events are expected to occur during the activity, the likelihood of their occurrence is not considered during the risk assessment, and only a consequence level is assigned.

For unplanned events, the consequence level of the impact is combined with the likelihood of the impact occurring (**Table 1**), to determine a residual risk ranking using Santos' corporate risk matrix (**Table 2**).

Project risk approach

To determine the residual risk on each of the three key environmental factors and objectives as a result of the Project, the greatest impact to each factor and objective was identified and taken through Santos' risk process of determining a likelihood and consequence rating for that impact following the application of mitigation and management measures. The outcome of the likelihood and consequence rating of the impact is an overarching residual risk rating for each of the three key environmental factors and objectives based on the greatest known impact.

Table 1 Likelihood description

No.	Matrix	Description
F	Almost Certain	Occurs in almost all circumstances OR could occur within days to weeks
E	Likely	Occurs in most circumstances OR could occur within weeks to months
D	Occasional	Has occurred before in Santos OR could occur within months to years
C	Possible	Has occurred before in the industry OR could occur within the next few years
B	Unlikely	Has occurred elsewhere OR could occur within decades
A	Remote	Requires exceptional circumstances and is unlikely even in the long term

Table 2 Risk Matrix

		Consequence					
		I	II	III	IV	V	VI
Likelihood	F	Low	Medium	High	Very High	Very High	Very High
	E	Low	Medium	High	High	Very High	Very High
	D	Low	Low	Medium	High	High	Very High
	C	Very Low	Low	Low	Medium	High	Very High
	B	Very Low	Very Low	Low	Low	Medium	High
	A	Very Low	Very Low	Very Low	Low	Medium	Medium

Table 3 Consequence descriptions

Consequence Level		I	II	III	IV	V	VI
Acceptability		**Acceptable**	**Acceptable**	**Unacceptable**	**Unacceptable**	**Unacceptable**	**Unacceptable**
Consequence Level Description		**Negligible** No impact of negligible impact	**Minor** Detectable but insignificant change to local population, industry or ecosystem factors Localised effect	**Moderate** Significant impact to local population industry or ecosystem factors	**Major** Major long-term effect on local population industry or ecosystem factors	**Severe** Complete loss of local population industry or ecosystem factors AND/OR extensive regional impacts with slow recovery	**Critical** Irreversible impacts to regional population industry or ecosystem factors
Environmental Receptors	**Fauna** In particular, EPBC Act listed threatened/migratory fauna or TPWC Act protected fauna	Short term behavioural impacts only to small proportion of local population and not during critical lifecycle activity No decrease in local population size No reduction in area of occupancy of species No loss/disruption of habitat critical to survival of a species No disruption to the breeding cycle of any individual No introduction of disease likely to cause a detectable population decline	Detectable but insignificant decrease in local population size Insignificant reduction in area of occupancy of species Insignificant loss/disruption of habitat critical to survival of a species Insignificant disruption to the breeding cycle of local population	Significant decrease in local population size but no threat to overall population viability Significant behavioural disruption to local population Significant disruption to the breeding cycle of a local population Significant reduction in area of occupancy of species Significant loss of habitat critical to survival of a species Modify, destroy, remove, isolate or decrease availability of quality of habitat to the extent that a significant decline in local population is likely Introduce disease likely to cause a significant population decline	Long term decrease in local population size and threat to local population viability Major disruption to the breeding cycle of local population Fragmentation of existing population Major loss of habitat critical to survival of a species Modify, destroy, remove, isolate or decrease availability of quality of habitat to the extent that a long term decline in local population is likely Introduce disease likely to cause a long term population decline	Complete loss of local population Complete loss of habitat critical to survival of local population Widespread (regional) decline in population size or habitat critical to regional population	Complete loss of regional population Complete loss of habitat critical to survival of regional population
	Physical Environment / Habitat Includes: air quality; water quality; benthic habitat (biotic/abiotic); particularly habitats that are rare or unique; habitat that represents a Key Ecological Feature; habitat within a protected area; habitats that include benthic primary producers and/or epifauna	No or negligible reduction in physical environment / habitat / area / function	Detectable but localised and insignificant loss of area / function of physical environment / habitat. Rapid recovery evident within ~2 year (two season recovery)	Significant loss of area and/or function of local physical environment / habitat. Recovery over medium term (2-10 years)	Major, large-scale loss of area and/or function of physical environment / local habitat. Slow recovery over decades	Extensive destruction of local physical environment / habitat with no recovery Long term (decades) and wide spread loss of area or function of primary producers on a regional scale	Complete destruction of regional physical environment / habitat with no recovery Complete loss of area or function of primary producers on a regional scale

Consequence Level		I	II	III	IV	V	VI
	Threatened ecological communities (EPBC Act listed ecological communities)	No decline in threatened ecological community population size, diversity or function No reduction in area of threatened ecological community No introduction of disease likely to cause decline in threatened ecological community population size, diversity or function	Detectable but insignificant decline in threatened ecological community population size, diversity or function Insignificant reduction in area of threatened ecological community	Significant decline in threatened ecological community population size, diversity or function Significant reduction in area of threatened ecological community Introduction of disease likely to cause decline in threatened ecological community population size, diversity or function	Major, long term decline in threatened ecological community population size, diversity or function Major reduction in area of threatened ecological community Fragmentation of threatened ecological community Introduction of disease likely to cause long term decline in threatened ecological community population size, diversity or function	Extensive, long term decline in threatened ecological community population size, diversity or function Complete loss of threatened ecological community	Complete loss of threatened ecological community with no recovery
	Protected Areas Includes: World Heritage Properties; Ramsar wetlands; Commonwealth/ National Heritage Areas; Land/ Marine Conservation Reserves	No or negligible impact on protected area values No decline in species population within protected area No or negligible alteration, modification, obscuring or diminishing of protected area values	Detectable but insignificant impact on one or more of protected area's values Detectable but insignificant decline in species population within protected area Detectable but insignificant alteration, modification, obscuring or diminishing of protected area values	Significant impact on one or more of protected area's values Significant decrease in population within protected area Significant alteration, modification, obscuring or diminishing of protected area values	Major long term effect on one or more of protected area's values Long term decrease in species population contained within protected area and threat to that population's viability Major alteration, modification, obscuring or diminishing of protected area values	Extensive loss of one or more of protected area's values Extensive loss of species population contained within protected area	Complete loss of one or more of protected area's values with no recovery Complete loss of species population contained within protected area with no recovery
	Socio-economic receptors Includes: fisheries (commercial and recreational); tourism; oil and gas; defence; commercial shipping	No or negligible loss of value of the local industry No or negligible reduction in key natural features or populations supporting the activity	Detectable but insignificant short-term loss of value of the local industry Detectable but insignificant reduction in key natural features or population supporting the local activity	Significant loss of value of the local industry Significant medium term reduction in key natural features or populations supporting the local activity	Major long term loss of value of the local industry and threat to viability Major reduction of key natural features or populations supporting the local activity	Shutdown of local industry or widespread major damage to regional industry Extensive loss of key natural features or populations supporting the local industry	Permanent shutdown of local or regional industry Permanent loss of key natural features or populations supporting the local or regional industry